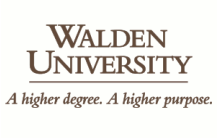

2016

Decision Making of Environmental Engineers on Project Selection

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
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2016

Abstract

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by

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MS, Walden University, 2010

BS, Thomas Edison State College, 2006

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Business Administration

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October 2016

Abstract

Some environmental engineers do not understand how to perceive profitable opportunities in redeveloping the large number of contaminated brownfield sites in New Jersey. The purpose of this qualitative exploratory case study was to find effective decision-making strategies that help environmental engineers acquire profitable environmental redevelopment projects. The target population consisted of 4 environmental engineers in an environmental organization in Camden County, New Jersey who possessed proven decision-making strategies that helped them acquire profitable environmental redevelopment projects in the past 5 years. The conceptual framework for this study was the multiple criteria decision method (MCDM). Semistructured interviews were conducted with the engineers, and company documents were additional sources of data gathered. Triangulation and member checking were used to ensure the trustworthiness of interpretations. Five themes emerged from the analyses relating to strategies for an MCDM assessment in project management, a go/no–go assessment in project selections, education and training, ethics as an organizational value, and project management. These findings may lead to social change in Camden County, New Jersey community organizations, such as schools, daycare centers, and local businesses, which may benefit from the knowledge and safety recommendations of remediation decision making. Furthermore, these findings may provide opportunities for environment organizations to teach and train stakeholders on environmental processes while providing profitable opportunities to shareholders through sustainable practices.

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Dedication

This doctoral study is dedicated to my husband, whose perseverance and fortitude continued to gird me up through completion, and to my children, who kept me focused on the project. This achievement would never have been reached without your loving support. My prayer is that you my children will carry on the mantle.

Acknowledgments

Appreciations are extended to my committee members, Dr. Carol Faint and Dr. Richard Snyder, for working with me to ensure that this study met the academic requirements of the university. I am thankful to Dr. Jill Murray for serving as my committee chair and mentor. Throughout this process, Dr. Murray was available for direction, support, and words of reassurance. It has been an honor and privilege to work with you all during this journey. Finally, I offer thanks to my dear friend, Dr. Rachelle Sutton, who collaborated with me throughout this long journey. It was my pleasure to have labored with you through this process. God has the victory as we both completed the journey.

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Section 1: Foundation of the Study

Properties with environmental issues that require redevelopment or remediation often require licensed environmental engineers to perform the remedial work. Environmental sites frequently contain high levels of contamination (Eckerd & Keeler, 2012). Contamination can mean chemical waste, mining waste, or fossil fuel waste (United States Environmental Protection Agency [EPA], 2013) and these conditions can pose environmental health risks. These sites sometimes require extensive and lengthy remedial work efforts, resources, and knowledge of local, state, and federal requirements (Eckerd & Heidelberg, 2015). The rewards for cleanup or remediation of the site can be profitable, providing that the workers do the work quickly and at a reasonable cost.

Issues with environmental cleanup are presently developing. According to Eckerd and Heidelberg (2015), many urban areas with environmental problems have been economically declining for decades. Complications with environmental work make this work slow and expensive, but it can produce significant returns for all parties involved (Bridges, Kiker, Linkov, Seager, &Varghese, 2005). Environmental engineers must make decisions as to which projects are salvageable (Eckerd & Heidelberg, 2015). Some of the collaborators involved in environmental cleanup include the environmental engineering company, the community, and the government (Eckerd & Keeler, 2012; Eisen, 2012).

Background of the Problem

In the late 1970s, contaminated properties reached national awareness when numerous toxic waste fires caused contamination nationwide (Eckerd & Keeler, 2012;

EPA, 2013). These events led President Carter and the U.S. Congress to pass the Comprehensive Environmental Response Compensation and Liability Act (CERCLA; EPA, 2013). This legislation–funded remediation of the most contaminated sites, called *superfund sites*, and set liability rules regarding the responsibility for past, present, and future damages (Eckerd & Keeler, 2012; EPA, 2013). In 1995, the EPA (2013) enacted its Brownfield Action Agenda to clarify liability issues and to support efforts of voluntary cleanup of so–called *brownfield* properties. A brownfield is a site or building that presents environmental contamination (EPA, 2013; Linn, 2013). The resulting revisions of federal laws allowed states to establish policy intended to lessen market constraints on brownfield redevelopment for private firms (EPA, 2013). State and federal environmental agencies had the task of remediating contaminated sites (EPA, 2013). To perform such tasks, municipal, state, and federal environmental agencies hire environmental engineers to remediate environmental issues.

Problem Statement

Contaminated commercial and industrial properties have environmental, social, and economic impacts on the sustainability of the communities in which they operate (Finkel, Morio, & Schadler, 2013). The U.S. Government Accountability Office (GAO) estimated that in 2004, 450,000 brownfield sites existed nationwide (Eckerd & Heidelberg, 2015). The general business problem was that environmental engineers do not always know how to choose the most profitable opportunities in environmental assessment and remediation, resulting in wasted time, effort, and money. The specific

business problem was that some environmental engineers lack effective decision–making strategies to facilitate the acquisition of profitable environmental redevelopment projects.

Purpose Statement

The purpose of this qualitative, exploratory case study was to find effective decision–making strategies that help environmental engineers acquire profitable environmental redevelopment projects. Using a single case study approach allowed the in–depth focus required for me to understand the acquisition efforts of one environmental remediation engineering firm in southern New Jersey. Carrying out environmental remediation projects can lead to positive social change through opportunities for the environmental engineering community to make profitable decisions that may include sustainability efforts, which could result in greener remediation projects. Profitable decisions and greener remediation projects offer additional ways for environmental engineers to help the environment by using sustainable practices.

Nature of the Study

For this study, I used a qualitative method with a single case study design. Qualitative research can involve interviews that elicit participants' responses (Bell & Bryman, 2011; Marshall & Rossman, 2014). A qualitative methodology suited this study because the research question reflected an exploratory inquiry that focused on how environmental engineers make the decisions that prioritize the remedial project opportunities available to environmental companies. A qualitative study allowed me to explore rather than rely on statistical data to answer the research question. Quantitative and mixed methods approaches did not offer appropriate methodologies for this study. A

primary feature of quantitative research is the use of statistics, which defines the relationship between data and observation and is dependent upon identified variables (Leedy & Ormrod, 2013; Marshall & Rossman, 2014). Since I did not identify or analyze such variables, a quantitative method was not appropriate. A mixed methods study involves combining the theoretical aspects of quantitative research and the practical aspects of qualitative research methods into a single study (Leedy & Ormrod). A mixed method design can achieve results that neither a qualitative nor a quantitative approach alone can do. This study was exploratory and, since I did not have any hypotheses as in a quantitative study, I ruled out a mixed methods approach. Issues that can arise in implementing a mixed method design are the high level of methodological sophistication needed in using the design and the time to complete it (Leedy & Ormrod).

A research design refers to a plan for exploring research questions and drawing conclusions from data to describe or explain the data in such a way as to answer the research question (Leedy & Ormrod, 2013). This study's research question guided the case study design, which was suitable to address the objectives of the study. Alternative designs to a case study include: (a) phenomenological studies, (b) ethnographic studies, (c) narrative studies, and (d) grounded theory studies (Leedy & Ormrod). A phenomenological researcher explores the lived experiences of the study's participants (Leedy & Ormrod). A case study allows the researcher to go beyond focusing on the lived experiences (Yin, 2014). It allows the researcher to focus on events, programs, individuals, and factors that influence the participant in his or her environment through a bounded system (Leedy & Ormrod). A case study design suited this study better than a

phenomenology design because I desired data that included the decision–making reasoning of individuals and not just the lived experiences of the individuals interviewed. While both a case study design and an ethnographic design use in–depth studies of an individual or a group, differences exist within each design.

Ethnography is the study of a culture or an ethnic group (Leedy & Ormrod, 2013). Ethnography did not fit this study well as I focused on decision–making processes, not the culture of the participants involved. A narrative design identifies a narrated chronological report of life stories and experiences by individuals (Denison, 2016; Leedy & Ormrod). I did not seek to gather life stories and experiences narrated chronologically by individuals, so a narrative design was not an appropriate fit. Researchers use grounded theory design when no existing theories fit a phenomenon and they want to design a new theory or conceptual model to understand the issue covered in the research question (Biraghi, Gambetti, & Graffigna, 2012). I did not try to design a new theory or conceptual model, and therefore, grounded theory was not an appropriate design for this study either. For this study, exploratory design was the appropriate type of design for this study because I relied on an established decision–making framework, the multiple–criteria decision–making (MCDM) theory.

Research Question

The central question that guided this study was: What decision–making strategies do environmental engineers use to help the acquisition of profitable environmental redevelopment projects? The research question reflects an exploratory inquiry that focuses on how environmental engineers make the decisions that prioritize the remedial

project opportunities available to environmental companies. Additionally, the research question addressesed the nature of the decision-making processes used by environmental engineers to help with the acquisition of profitable environmental redevelopment projects.

Interview Questions

I employed a set of interview questions developed by Strider (2013) for understanding ethical decision making in the context of stakeholder interest. I used the following interview questions to gather data:

1. What factors in your background influence the formation of your business decision–making experiences?
2. What are examples of experiences that contributed to defining your decision–making standards?
3. What person (s) or event (s) in your background helped form your decision–making standards and how did the person (s) or event (s) help?
4. What characteristics of those events or experiences have you carried with you and how do the events or experiences that you have carried with you influence your decision making?

The next set of questions targeted the values of the participants' organization and allowed me to explore how the company defines profitable decision making. Furthermore, the questions enabled me to explore formal and informal mechanisms such as those described in the conceptual framework and literature review.

5. What personal attributes do environmental engineers in your organization exhibit that constitute profitable decision–making skills?

6. Who (what departments or level of employee) participates in decision making?

7. What instruction does the organization provide for decision making?

8. What does decision–making instruction consist of?

9. How do you determine supplier selection pertaining to brownfield remediation?

10. How do you choose what method you will use for brownfield remediation projects?

11. Does the method vary with the type of project?

12. Please explain how and why the method (does or does not) vary based on the type of brownfield remediation project?

13. Do you incorporate green remediation (GR) into your project selection? Why or why not, and if you do, how do you do it?

I used the final set of questions to explore how leadership beliefs and actions influence decision making. The questions were useful for an evaluation of the role and importance of profitable decision making to the organization.

14. How are business profit and or green initiatives applied to day–to–day business decision making?

15. How does the organization define profitable decisions and how many, if any, profitable decisions have been made in the last 5 years?

16. How many nonprofitable decisions has your company made in the last 5 years?

17. How does your company reward profitable decision making, and what, if any, are the consequences of nonprofitable decision making?

18. What additional information would you like to add that I did not ask?

Conceptual Framework

The conceptual framework that guided this study was the MCDM theory. Researchers have provided evidence that MCDM is used in environmental decision making (Charnes, Cooper, & Fergerson, 1955; Contini & Ziont, 1968; Kaklauskas, Trinkunas, & Zavadskas, 2007; Wallenius & Ziont, 1976). To date, there exists a large amount of research on the subject of environmental decision–making processes (see Appendix A). Using a series of web queries, Huang, Keisler, and Linkov (2011) found that over 300 papers published between 2000 and 2009 reported MCDM applications in the environmental field. The principles of MCDM include ways to assess values and preferences and make them explicit; integrate objective data with preferences and values; promote high level, decision level, and decision–related communication among involved stakeholders; make a decision–making process transparent and consistent; and update previous decisions when new information becomes available (Durbach & Stewart, 2012).

Project managers at the participating organization used some of the MCDM analysis tools that help in decision making. Environmental engineers have used MCDM methods in environmental management challenges (see Appendix A), and because of these MCDM methods, many analyses, theories, and processes have been postulated. The MCDM theory applied to this study as MCDM includes goal–directed behavior in the presence of options and uncertainty (Durbach & Stewart, 2012). Working in the

environmental business brings much uncertainty and many options, which complicates having to decide how and whether to undertake projects (Bridges et al., 2005; Maxim, 2014). For example, one can use the MCDM theory can to explain the relationships between variables and offer descriptive information for environmental engineers to decide whether they can maximize profits and, at the same time, minimize toxic exposure. Using MCDM can offer effective decision–making tools for use in remediation projects.

Operational Definitions

Brownfield: A brownfield is a property, the expansion, revitalization, or salvage of which may be complicated by the existence or potential existence of a harmful material, pollutant, or chemical (EPA, 2013).

Brownfield remediation: Brownfield remediation refers to a EPA program that, in partnership with states, municipalities, governments and other stakeholders in economic improvement, works collectively to prevent, assess, safely eliminate, and sustainably reuse brownfields (EPA, 2013).

Environmental decision making: Environmental decision making refers to the ways by which different people and organizations make choices that affect the environment (EPA, 2013).

Environmental engineer: An environmental engineer is an engineer who specializes in the use of engineering sciences and technology to solve environmental problems (U.S. Bureau of Statistics, 2014).

Fuzzy logic: Fuzzy logic is an approach to evaluation based on levels of truth rather than true or false logic (Durbach & Stewart, 2012).

Greenfield site: A greenfield site is an unindustrialized or woodland site zone for commercial development or industrial projects. A greenfield site may be a brownfield site if the site is polluted (EPA, 2013).

Pairwise approach: The pairwise approach takes pairs of information as instances in data and validates the difficulty of information to rank as that of classification (Abbott & De Vita, 2013).

Revitalization: Revitalization refers to the attempt to return contaminated land to productive use (EPA, 2013).

Stakeholders: Stakeholders are persons who have an interest in the decisions of an establishment or project (EPA, 2013).

Sustainability: Sustainability refers to the process by which society takes into account the needs of the existing generation without compromising the environmental conditions needed by future generations (White, 2013).

Assumptions, Limitations, and Delimitations

Assumptions

I made three assumptions that shaped this study. According to Yin (2014), assumptions are statements taken for granted or considered true. Furthermore, assumptions are principles accepted as being true based on logic or reasoning without proof or verification (Yin, 2014). First, I assumed that this single case study would provide value to environmental professionals. Second, since this study was to determine

decision–making processes used by environmental engineers in the environmental remediation industry, I assumed that participants had the ability to recollect decision making and be truthful when responding. It is critical to the findings of the study that participants be truthful in their responses (Doody & Noonan, 2013). Third, because environmental engineers make the decisions on which projects are salvageable and are beneficial to undertake and which ones are not, I assumed that participants have sufficient knowledge of the phenomenon to describe decision–making experiences.

Limitations

I identified two limitations that shaped this study. Yin (2014) described the limitations of a study as elements of research perceived as weaknesses or problematic in relation to the study. The limitations of this research project involved data collection, the validity of the questions asked of each participant, and generalizability. The first limitation of the study was that some environmental professionals may not have wanted to share decision–making practices pertaining to project selection. Second, the interview questions must support the study. The third limitation was that the defining characteristic of the case study approach was the focus on a single instance, which restricted the ability to generalize findings to other organizations or cases (Furgerson & Jacob, 2012).

To mitigate these limitations, I selected an engineering firm that was willing to share decision–making practices. I also made sure to not divulge any trade secrets or minimize any competitive edge that the company had or wished to maintain. Additionally, I ensured that the questions asked captured participants' actualities by making sure to identify weaknesses in the questions and by addressing potential ethical

gray areas (Andersen et al., 2013). I made sure that all participants had the right to define perceptions, moral values, and principles as they perceived them. Finally, I made sure that I gave a sufficiently rich description of the phenomenon under investigation so that those who review the study can have a proper understanding of decision making, thereby enabling the reader to compare the results of the study with other organizational situations or cases.

Delimitations

Three delimitations shaped this study. Delimitations are attributes that regulate the scope and delineate the boundaries of a study (Yin, 2014). The delimitations of this research project were the single case study approach, location of the data collection, and the type of interview structure used. I chose not to interview the environmental engineers and the acquisition teams from multiple engineering firms, even though such comparisons might be valuable. The location of the data collection limited this study's results. I collected data from just Camden County, New Jersey. Securing data from a larger region than Camden County may have allowed for more creative ideas and suggestions. I did not use structured interviews to maximize the uninhibited information that semistructured interviews can offer.

Significance of the Study

The significance of this study lies in assisting environmental engineers in handling general and fundamental decision–making problems connected with strategies to facilitate the acquisition of profitable environmental redevelopment projects. This study will be of value to the business community because I focused on environmental

engineering organizations that developed the technological proficiencies, social responsiveness, and professional viewpoints necessary for offering solid remediation solutions that can make a change in the community and in environmental engineers' practice. The EPA (2014) offered competitive cooperative agreements totaling $1.4 million in 2014 to nonprofit and tribal organizations to collaborate with stakeholders across industry, government, and academic circles in order to develop and put into practice solutions that focus on environmental issues in societies. The different frameworks of MCDM are effective, reproducible business practices (International Society on Multiple Criteria Decision Making, 2012). This study contributes to effective business practices because, by using MCDM, environmental engineers can use evidence (the best and most appropriate information) to guide decision–making processes to extract practicality from data and information (Durbach & Stewart, 2012) for the betterment of society. The results of this study contribute to positive social change by allowing environmental engineers to use MCDM to prioritize projects based on economic advantages as well as nonmarket benefits, such as improved social conditions for residents of communities that live in and around contaminated sites.

A Review of the Professional and Academic Literature

The purpose of this qualitative, exploratory case study was to find effective decision–making strategies that help environmental engineers acquire profitable environmental redevelopment projects. To gain a deeper understanding of the decision making of successful environmental engineers on project selection, I conducted an exploration of the key components of the previous literature on the topic. I reviewed over

400 articles found using Google Scholar searches and the databases available through the Walden University library. Among the articles used for this study, 97% were peer reviewed and 87% were within five years of expected chief academic officer approval. Ninety–three peer–reviewed sources appear in the academic literature review. The research question for this study addressed the nature of the decision–making processes used by environmental engineers to help with the acquisition of profitable environmental redevelopment projects. I included the following topics in the literature review: (a) an understanding of MCDM and multiple criteria decision analysis (MCDA); (b) brownfield redevelopment projects; (c) an assessment of environmental cleanup; (d) uncertainty in environmental decision making; (e) decision–making tools already used in assessing environmental projects, such as analytical hierarchy process (AHP), decision–making trail and evaluation method (DEMATEL), analytical network process (ANP), and life cost analysis; and (f) sustainability in environmental decision making.

Multiple Criteria Decision Making (MCDM)

Environmental industry leaders use multicriteria assessments in cases when numerous options based on multiple considerations need to be evaluated (Agarski, Borut, Hodolic, & Kosec, 2012). Decision making in environmental undertakings is complicated, mainly because of the fundamental trade–offs between sociopolitical, environmental, ecological, and economic factors (Gomes & Partidario, 2013). The tradeoffs that project managers handle between agencies and organizations lead to many approaches to project selection. The selection of suitable remedial approaches for contaminated sites, land use planning, and regulatory methods often involves multiple

criteria such as financial difficulties, cost retrieval, liability matters, and maintaining a vision of redevelopment (Eckerd & Heidelberg, 2015). Multicriteria tools offer a methodical, thorough decision framework for environmental management (Critto et al., 2015). Eckerd and Heidelberg (2015) identified many tools to choose from when doing remediation and maintained that knowing the best tool or strategy is important because environmental issues often encompass ethical and moral values that are not associated with any economic use or value. Making important decisions in the absence of sufficient information and tools not only hinders one's performance and ability to maintain ethical and moral values but also often hurts other stakeholders (Fast, Galinsky, Mater, & Sivanathan, 2012).

Researchers offer little direction about decision approaches that offer profitable opportunities for environmental projects. Agarski et al. (2012) stated that, depending on the goal, researchers could choose from various evaluation methods that differ in limitations, in data standardization techniques, and in the methods for assessments of alternatives. Many have tried to formulate a tool that combines criteria to come up with a better way to make environmental decisions (Eckerd & Heidelberg, 2015), but a gap in the research exists. This gap in the research relates to the existing decision approaches, which offer little direction on how to evaluate the relative significance of information from each resource (Agarski et al., 2012). Barreteau et al. (2013) stated that effective environmental management requires an understanding of the interactions between policy choice and complex social, economic, technical, and environmental processes and related aims. A mixed methods approach that can help in project selection could be on the

horizon (Banaitienė et al., 2015). While environmental decision–making strategies over the last several decades have evolved into complex, information–intensive, and multifaceted approaches, frustration remains among all stakeholders (Agarski et al., 2012). Stakeholder frustrations are with existing management strategies, and the reason for the dissatisfaction is that combining multiple methodologies may result in the inability to track inconsistent stakeholder preference (Banaitienė et al., 2015).

Elimination and choice expressing reality (ELECTRE) and the preference ranking organization method for enrichment of evaluations (PROMETHEE) are two methodologies used in environmental decision making. Balali, Roozbahan, and Zahraie (2014) used the ELECTRE methodology and the PROMETHEE methodology in a case study to assess decision–making methods. The results of the case study showed that the ELECTRE and PROMETHEE could act as a proper tool for decision making in construction management processes because the approach includes decision matrix data, criteria weights, preference, indifference, and veto thresholds (Balali et al., 2014). Additionally, ELECTRE and PROMETHEE methods include a set of interval values that consider uncertainties in the decision–making procedure (Balali et al., 2014). PROMETHEE methods include finding criterion values of selected indicators and weights by using preference meanings with few limitations (Podvezko & Podviezko, 2010). Bhadauria, Green, Meacham, and Zelbst (2012) conducted a case study to investigate the relationships between green practices of supply chain management and supply chain performance. They derived a conceptual MCDM model from the data analysis and used the model to assess the influence of green practices on supply–chain

performance. This model provided the authors with evidence as to which green practices have positive effects on quality, customer satisfaction, and efficiency.

Multicriteria decision making is an important application in making profitable decisions for environmental projects. Many researchers have devoted themselves to understanding MCDM (Bouyssou, 1986; Chan, Madaan, & Wadhwa, 2009; Gal & Hanne, 2006). The MCDM theory proved to be instrumental in this study as environmental engineers use this model to make important decisions on environmental remediation. Past literature reviews comprise hundreds of publications that include research on MCDM (Behzadian, Ignatius, Otaghsara, & Yazdani, 2012). Appendix A provides case study findings of research on MCDM paradigms and the earliest applications.

Multiple Criteria Decision Making (MCDM)

MCDM is one way of improving the quality of decisions by making the process transparent, realistic, and useful. MCDM is one of the most commonly used decision methodologies in the science, business, and engineering worlds (Hester & VelaIQuez, 2013). Turskis and Zavadskas (2011) stated that MCDM problem–solution methods differ in difficulty with each method having strengths, limitations, and opportunities. Liou and Tzeng (2012) commented on Turskis and Zavadskas's research, stating that they failed to take into account many significant new concepts in the MCDM field, and suggested their own theories not addressed in Turskis and Zavadskas's research. Turskis and Zavadskas stated that a major problem with MCDM methods is that different techniques offer different results when applied to the same problem. Liou and Tzeng

stated that when using traditional assessment tools, although hierarchically structured, one can assume the criterion is unsubstantiated by outside influences.

There are MCDM assessment tools designed to address problems environmental decision making. Turskis and Zavadskas (2011) introduced a new additive ratio assessment (ARAS) method. This is an MCDM assessment tool that has been used in environmental projects. When using the ARAS method, an efficient function value that determines the difficult comparative efficiency of a possible alternative is directly related to the relative effect of values and weights of the main criteria considered in a project (Turskis & Zavadskas). Liou and Tzeng (2012) introduced their own multiple objective decision making and multiple attribute decision–making techniques, which were not included in the works of Turskis and Zavadskas. One of the main purposes of Liou and Tzeng's multiple objective decision–making method is to analyze planning and design problems with multiple objectives and criteria based on a variable decision making, as opposed to Turskis and Zavadskas's traditional assumptions of constant limitation environments. One way to do such an analysis is to use fuzzy parameters, which I will discuss later in the literature review. One of the tendencies within MCDM is to analyze gaps between objectives and linked goals (Agarski et al., 2012). Liou and Tzeng offered findings as a supplement to Turskis and Zavadskas's research, suggesting additional concepts designed to solve real problems encountered in traditional methods of decision making.

Durbach and Stewart (2012) determined that all multicriteria methods have a commonality, namely that breaking down the assessment of alternatives into assessments

on a number of inconsistent criteria important to the problem can improve most decisions and decision making. Environmental decision making has become more information–intensive and complex (Bates, Linkov, Madison, & Tsang, 2014). Environmental professionals must decide what they want to accomplish through environmental management and how much they are willing to charge to do the work. MCDM tools offer methodically sound decision frameworks (Bates, Linkov, Madison, & Tsang, 2014). In this literature review, I will discuss some of the different types of multiple criteria methods used in decision making.

Brownfield Remediation

The revitalization of brownfields is a great environment for decision making (Bleicher, Finkel, Gross, Morio, & Schadler, 2013). The EPA definition of a brownfield is a property, the expansion, revitalization, or salvage of which may be complicated by the existence or potential existence of a harmful material, pollutant, or chemical (EPA, 2013). In the late 1970s, contaminated properties reached national awareness when numerous toxic waste fires caused contamination nationwide (Eckerd & Keeler, 2012; EPA, 2013). These events led President Carter and the U.S. Congress to pass the CERCLA (EPA, 2013). In 1995, the EPA enacted the Brownfield Action Agenda to clarify liability issues and to support efforts of voluntary cleanup of brownfield properties (Eckerd & Keeler, 2012; EPA, 2013). New Jersey has made more CERCLA progress than any other state (EPA, 2013; Rath, 2012). Highly developed, densely populated, and heavily industrialized, New Jersey is one of the most contaminated states in the nation (EPA, 2013; Rath, 2012). A lot of environmental cleanup is necessary in this state and

that is one of the reasons I chose this state to conduct my study. New Jersey is home to one–quarter of the superfund sites (EPA, 2013; Rath, 2012). The state represents the most advanced test of the wisdom of environmental professionals (EPA, 2013; Rath, 2012).

When tests identify contamination, safety, health, and environmental professionals are responsible for managing, assessing, and remediating the properties (Eckerd & Keeler, 2012). Environmental protection policy regarding remediation is specific to the type and degree of contamination (Gomes & Partidario, 2013). Contaminated sites frequently pose a risk to the local environment and the users of the site, so owners usually remediate them (Binning, Bjerg, Chambon, & Lemming, 2012). The process of evaluating and redeveloping brownfield sites is complicated and requires a multitude of decisions, such as the identification of possible brownfield sites, choosing which sites are worth additional inspection for redevelopment, performing risk assessments, designating suitable remediation actions, coming up with appropriate redevelopment plans, and choosing the applicable funding resources (Bagtzoglou et al., 2012). An appropriate environmental strategy together with comprehensive decontamination expertise is of great concern because sound decision making can save money and time by focusing efforts that balance practicality, regulatory requirements, sustainability, and cost–effectiveness(Gomes & Partidario, 2013). Decisions on environmental projects are a typically complex and confusing activity (Binning et al., 2012). Decisions on remediation are difficult management issues because the evaluation of contamination has uncertainties, for example, when the relation to the cost of

remediation is high and when the outcomes are numerous and vital to public health, environmental quality, and the economy (Gomes & Partidario, 2013).

Initially a pilot, the EPA Brownfields Program was developed and given legislative support by the Small Business Liability Relief Brownfields Revitalization Act of 2002 (Blackman, Lyon, Novak, & Wernstedt, 2013). The large scale of contamination in the United States has prompted legislators to start brownfields state–by state programs (Davies, Ruple, & Uchitel, 2013). By implementing this brownfield programs, there has been a decline in contaminated sites but most brownfield projects are not revitalized due to not having a profitable strategy (Eckerd & Heidelberg, 2015). There are viable markets for brownfield remediation in areas where laws ensure ease of access to sites (Blackman, Lyon, Novak, & Wernstedt, 2013). Effective brownfield revitalization programs require community support, with public and private collaborations building local brownfield capacity (Al-Tabbaa, Hou, & Luo, 2014). Roseland (2012) advocated for brownfield remediation so that sustainable neighborhoods can be built where there were previously contaminated sites. A part of Roseland's argument for brownfield remediation is to encourage growth that helps realize community livability, suitable access, and less traffic. Eckerd and Heidelberg (2015) posited that creative use of local, state, and national funding options could benefit municipalities and residents in restoring brownfield properties to public use.

Eckerd and Keeler (2012) concluded that the rate of remediation of brownfield sites in communities with majority–minority populations is lower than in other communities. Bottero, Ferretti, and Mondini (2014) conducted a study using ANP on the

reuse of historic buildings and found that ANP can actually capture the interdependencies among various criteria. Bottero et al. found that ANP enables decision makers to understand the complex issues in building reuse selection problems. Chen, Huang, Ko, and Wang (2014) suggested that people expect managers to use resources wisely and responsibly, and to protect the environment.

Assessment of Environmental Cleanup

Managing a remediation project requires qualified professionals, such as employees of an engineering firm (Eckerd & Keeler, 2012). The management of contaminated sites is not solely a matter of whether or not a site is contaminated and is in need of remediation, but also how possible remediation is (Aye, Duffield, Lai, & Zhang, 2014; Binning et al., 2012). For a firm to be profitable, cost effectiveness requires knowledge of safety and health issues applicable to identifying contamination, understanding of local and federal remediation regulations, and expertise in simplifying the assessment and remediation process (Eckerd & Keeler). Even though uncertainties in the environmental field are present, much interest exists, such as high cost, sustainability, and multiple impacts on the environment (Gomes & Partidario, 2013). As a stakeholder in the management of the project, the environmental professional is involved with ethical decision making and piloting the project toward the successful desired completion (Eckerd & Keeler).

Murayama and Sharif (2012) stated that although neighborhood planning has a relatively long history, it was not until the early years of the 21st century that planners and environmentalists began to design tools for sustainability assessment on the

neighborhood scale. Haapio (2012) stated that scholars have developed numerous building environmental assessment tools for the building sector to help in making decisions and to improve the environmental performance of buildings and building stocks. Murayama and Sharif argued that brownfield remediation methods progress with respect to the type of technologies available for assessing and treating contaminants. However, decision making for remediation is a means to integrate the goals of multiple stakeholders (Haapio).

Kim, Parker, Unger, and Yu (2012) indicated that a paramount difficulty in brownfield redevelopment is the lack of a methodology for the developer to value uncertainties. Developing an uncomplicated assessment methodology could assist developers, municipalities, regulators, and communities to assess brownfield sites better and to foster revitalization successfully (Murayama & Sharif, 2012). Scholars have developed several remediation tools recently for the cleanup of contaminated sites (Gomes & Partidario, 2013). Appendix B offers various applications of decision support tools in environmental management. Emerging technologies can be essential instruments in facing the crucial problems of environmental recovery (Gomes & Partidario). Many options to reduce environmental impact exist (Baker et al., 2013). Decision making on the use of remediation options is important after a comprehensive analysis of contaminant and pollutant effects on the environment (Gomes & Partidario). The selection of suitable technologies is problematic but significant in the successful remediation of contaminated sites.

Risk and Uncertainty

In this subsection, I will discuss risk assessment with weight of evidence and uncertainty with data collection validity, using foresight systems and scenario planning tools to deal with uncertainty and risk. Uncertainty is a core issue for strategic decision makers (Hipel, Kilgour, & Kuang, 2015; Vecchiato, 2012). Application of risk management has developed significantly in diverse organizations and research fields (Arena et al., 2013). Some of the most troubling risk–management challenges are associated with uncertainties (Cox, 2012; Culhane et al., 2014). Environmental uncertainty results from managers' perceptions that business environments are unpredictable (Borisov & Lueg, 2014). The practice of MCDA affects the assessment of a set of possible options or alternatives (Durbach & Stewart, 2012). Facilitating decisions in an environment of uncertainty entails a choice of how to do business with uncertainty.

Critto et al. (2015) introduced a method used in environmental management known as the weight of evidence (WOE), which includes the assessment of an individual line of evidence to form a conclusion. WOE methodology applies to several human and environmental assessments that also take into account the assessment of risks associated with site pollution, choice of criteria, standards, permit levels and calculation of outcomes from corrective interventions. To illustrate the difference in the application of WOE methods, Critto et al. developed a case study based on nanomaterial hazard resulting from physico–chemical and toxicological properties of nanomaterials. Several WOE methods existed such as recording evidence, best professional assessment and judgment, fundamental standards, scoring, indexing, and measurable evaluation (Critto et

al., 2015). Benefits and drawbacks to all of them are present, and Critto et al. were most impressed with the fact that a quantitative methodology is available to determine how to clean up a contaminated lake. Critto et al. found that WOE worked as a quantitative technique for remediation alternatives. The intent of using WOE was to provide assessors with a quantitative alternative for weighing evidence that is adaptable to any system. Critto et al. did not intend the different methods used to be rigorous applications of the methods; rather, they illustrated the manner in which each method assesses information and found that the WOE model can form part of a larger decision framework or can work independently.

Durbach and Stewart (2012) provided a review of MCDA for cases when attribute evaluations are uncertain and identified different tools for decision making. Five uncertainty formats discussed were possibilities, decision criteria, risk assessments, fuzzy numbers, and scenarios. Decision analysis based on probabilities included multi–attribute utility theory (MAUT) and expected utility theory (EUT). EUT is a known model of decision making under uncertainty (Durbach & Stewart). EUT does not sufficiently illustrate stakeholders' choices. The decision weights model characterizes additional probabilities (Buchholz & Schymura, 2012; Chen & Park, 2015; Durbach & Stewart; Morgenstern & von Neumann, 1953). Durbach and Stewart suggested that when making decisions, people weigh the significance of uncertain conclusions by elements that do not relate to the accompanying probabilities such as weighting factors. This research conclusion is contradictory to Critto et al.'s (2015) findings.

Durbach and Stewart (2012) and Jiménez, Mateos, and Sabio (2013) additionally found that while probability theory or MAUT are primarily factual theories, MAUT's effect has researchers searching for models that are more receptive to the difficulties and limitations of decision weights. Concerns about the implementation capability of MAUT/multi–attribute value theory led to the development of the simple multi–attribute rating technique (SMART). SMART is a fundamental multi–attribute rating approach, which utilizes simple utility relationships (see Appendix B). Explicit risk attributes measure the results of uncertainty as a characteristic. This approach indicates how unpredictable or risky performance is. Decision analysis based on fuzzy numbers can pattern the factors of the decision–making process that depend on uncertainty using fuzzy sets and numbers. Methods found under the fuzzy technique (see Appendix B) are the analytic hierarchy process (AHP) and the technique for order of preference by similarity to ideal solution (TOPIS) method (Durbach & Stewart). The AHP technique uses a qualitative approach to the pairwise comparisons made. AHP uses a 1–9 scale; the points along the scale have meanings, and the comparisons often make use of the labels. A considerable amount of research brings out the inconsistency in the AHP method because many ways to judge the marginal information exist, which I discuss in the next section.

TOPIS reflects the uncertainty of input data and criteria weighting values (Chung, Jeon, & Lee, 2013). Technique for order of preference by similarity to ideal solution (see Appendix B) begins by defining two theoretical options (Durbach & Stewart, 2012). Using the technique, one can assess alternatives based on distances to the best solution expressed as a proportion of the sum of the two distances (Chung et al., 2013). Many, if

not all decision models are fuzzifiable because nearly all processes that are active in this decision model have fuzzy styles, e.g., addition, multiplication, finding a minimum and maximum (Durbach & Stewart). Project managers use fuzzy risk scores to assess risk (Durbach & Stewart). Scenarios are incomplete explanations of how the future might develop, with importance placed on the development of instrumental reasoning that allows the decision maker to gain an understanding of the problem and to provide insights into possible courses of action (Barber et al., 2012). Scenario planning is a strategic tool whose use has increased significantly in the last decade and is one of the most used tools in strategy development when risk and uncertainty need to be addressed (Vecchiato, 2012). Research on MCDA is growing (Montibeller & Ram, 2013).

Tools Used in Decision Making

Analytical hierarchy process (AHP). The AHP is prevalent in the application of multiple criteria in decision–making problems (Alem, Jolai, & Nazari–Shirkouhi, 2013). Strategic decision making is demanding and essential for organizations (Montibeller & Ram, 2013). Methods found under the fuzzy technique include AHP (Durbach & Stewart, 2012). Leaders can use AHP to solve MCDM problems, particularly when qualitative assessment parameters are involved (Büyüközkan, 2012). As stated earlier in the risk and uncertainty section, AHP technique uses a qualitative approach to the pairwise (occurring in pairs) comparisons made. Scores of research studies bring out the inconsistency in the AHP method because a variety of ways to process the information subsists (Durbach & Stewart).

Kuo and Lu (2013) wrote about using AHP approaches to make decisions and to make comparisons among contracts for construction. Tamošaitienė, Turskis, Vainiūnas, and Zavadskas (2012) conducted a case study using the AHP and ARAS methods to evaluate project managers for construction projects. Every alternative MCDM problem has a set of constraints (Kuo & Lu, 2013). Tamošaitienė et al. intended the case study to find the methodology that might serve as a decision support aid in assessing project managers. Kuo and Lu used the AHP method in conjunction with the consistent fuzzy preference relations (CFPR) to deal with the issue of inconsistency in data collection. The researchers employed AHP and CFPR to evaluate the impact of identified risk factors on project performance in metropolitan construction projects.

Tamošaitienė et al. (2012) determined criteria weights by using the decision support system (DSS) technique. Decision–making problems are too multi–faceted for a single measurement criterion to work (Kuo & Lu, 2013; Tamošaitienė et al.). The decision maker has to use different weight arrangements in the decision–making process according to the requirements of the method. The integrated AHP and CFPR methods provided a straightforward approach to gauge inconsistencies in risk factors for construction projects. Tamošaitienė et al. discussed the ease of assessing and ranking decision alternatives when the AHP and ARAS methods are used. Kuo and Lu stated that the CFPR and AHP approach not only assesses overall project risk, but its concept can also be used to evaluate the risk of a series of work items such as excavation, structural work, concrete work, and electrical work, when a detailed ranked construct of risk factors

for the project is established. Shankar, Shaw, Thakur, and Yadav (2012) provided an extensive study of supplier assessment and selection problems.

Businesses have increasingly seen supplier selection and evaluation as strategic subjects (Ageron, Gunasekaran, & Spalanzani, 2012; Dursun & Karsak, 2014). Researchers have explored various decision–making methods to deal with the concerns (Govindan, Murugesan, Rajendran, & Sarkis, 2013). Having the right decision–making method can help managers to form strategic partnerships with exceptionally performing suppliers. Integrating good suppliers within a project can reduce costs by excluding waste, striving for zero defects in quality, improving on meeting the needs of the end–customers, and reducing lead–time at various stages of the supply chain (Liou & Tzeng, 2012; Turskis & Zavadskas, 2011).

Govindan et al. (2013) reviewed the literature on MCDM methods for supplier assessment and selection. Govindan et al. analyzed articles appearing in the research from 1997 to 2011. First, the researchers' studied different approaches and then identified the most prominent approach. There were various approaches that focused on qualitative and data envelopment analysis (30%), mathematical programming (17%), analytical hierarchy process (15%), case–based reasoning (11%), analytical network process (5%), fuzzy set theory (10%), SMART (3%), genetic algorithm (2%), criteria–based methods (7%), as well as 808 quantitative factors pertaining to the needs and specifications of the buyers (Govindan et al., 2013). The most widely applied methodology was environmental management systems, mainly attributed for its robustness (Govindan et al.). Cost was a factor identified in the research. Cost shifted down the line with respect to its importance

in evaluating the suppliers, while quality and delivery performance climbed up the hierarchy (Govindan et al.).

The most effective quality of AHP is numerical priorities (such as cost and other mathematical factors) from subjective knowledge expressed in the assessments of paired comparison patterns (Mitkus et al., 2011). Govindan et al. (2013) stated that non–cost–based MCDM methods are better than cost–based methods because non–cost–based multi criteria methods aid decision makers in applying the different models effectively. Govindan et al.'s literature review brought forth numerous individual and integrated approaches that proposed to solve a supplier selection problem. Govindan et al. concluded that supplier selection is a MCDM problem, which involves multiple assessment criteria such as price, value, quantity, and method, and therefore it is possible to use MCDM methods to assess suppliers. Of the MCDM approaches, the AHP method, is most suitable for developing qualitative criteria through extensive functions in all types of areas such as choice, assessment, preparation, development, and decision making (Govindan et al., 2013).

Decision–making trial and evaluation laboratory (DEMATEL). Fontela and Gabus (1976) proposed the DEMATEL method in 1971 to handle complex problems by considering stakeholders' viewpoints (Ahmed, Falatoonitoosi, & Sorooshian, 2014). The foundation of the DEMATEL method is graph theory, enabling stakeholders to design and solve problems visually, and to make possible the dividing of multiple criteria into cause and effect groups to understand casual relationships better (Tzeng & Wang, 2012). Buyukozkan and Cifci (2012) and Chen, Hu, Hsu, and Kuo (2013) applied DEMATEL to

make decisions in a fuzzy and uncertain environment, particularly during the selection of green suppliers. Decision–making purposes, such as supplier selection, include the understanding of evidence based on several criteria rather than on a single preferred approach (Jain, Kumar, & Kumar, 2014). Multicriteria evaluation frequently requires decision makers to identify alternatives based on the value in relation to the project by performing qualitative/quantitative assessments (Banaitienė et al., 2015). Such assessments will usually result in speculative information, which makes the decision–making process difficult and challenging (Banaitienė et al.).

The DEMATEL method used by Hsu, Tzeng, and Wang (2012) verified the effect of vendor selection (VS) criteria and applied results to regulate the unweighted environment in the ANP. The ANP is an extension of AHP (Hsu et al., 2012). The ANP is a nonlinear structure, whereas the AHP is hierarchical and linear, with goals at the top and alternatives at lower levels (Hsu et al.; Saaty, 1999; Tzeng & Wang, 2012). Chai, Liu, and Ngai (2013) stated that, despite the significance of decision–making techniques for VS, no systematic literature review exists. Chai et al., like Govindan et al. (2013), conducted a literature review of articles published from 2008 to 2012 on the application of decision–making assessments for VS. Hsu et al. used an MCDM model combining DEMATEL based on ANP and visekriterijumska optimizacija i kompromisno resenje' (VIKOR, which translates as multicriteria optimization and compromise solution) to solve a recycled materials VS problem of multiple scopes and criteria that are codependent, instead of using the independent theory of an AHP process.

Analytical network process has worked well in many practical decision–making problems, such as project selection, supply chain management, and optimal scheduling problems (Chou, Hwang, Lee, Lin, & Tsai, 2013; Hester & VelaIQuez, 2013; Hsu et al., 2012). VS is an important issue in supply–chain management. Chai et al. (2013) used a scientific decision analysis in four aspects, namely decision difficulties, decision producers, decision situations, and decision methods. They mainly reviewed techniques that combined decision methods in the literature regarding AHP, ANP, and DEMATEL. Chai et al. reviewed 123 journal articles to examine the research trend in uncertain supplier selection and showed that VS is one of the MCDM problems in strategic supply–chain management. VS is a complicated process because fuzzy areas may vary across the different product groups and purchase conditions.

Environmental pollution is another challenge faced by building companies that focus on GR (Zhang, 2013). Construction companies endeavor to solve these issues to improve the environmental sustainability of green building projects by using different building methods (Al–Tabbaa & Hou, 2014). The selection of the methods for building projects involves a multi–faceted decision–making process (Chang, Hsu, Lee, Lin, & Tsai, 2013). To solve this problem of method choice, Chang, Hsu, Lee, Lin, and Tsai (2013) introduced an MCDM approach that combined DEMATEL, ANP, and zero–one goal programming (ZOGP). Kuo and Lu (2013) stated that the success of building methods largely depends on effective contract preparation and criteria. Chang et al. examined the effects of different perspectives and the relationship between unrelated groups using DEMATEL. They then used the ANP method to establish a decision–

making model and to assess the importance of the building process for each project (Chang et al.). Chang et al. were unable to determine the best alternatives for limited economic resources and used a ZOGP algorithm. Tamošaitienė et al. (2012) determined criteria weights by using the decision support system (DSS) technique. They found that three sets of criteria were best for construction contacts based on the functions associated with particular conditions: (a) the criteria based on the information in the contract, (b) criteria based on specific types of conditions, and (c) a set of criteria based on the connotations related to certain environments.

Handling the aspect of cost reduction, Chang et al. (2013) combined the weightings derived from ANP and ZOGP to determine the best GR method for each green project with limited financial resources to maximize the profit of an organization. Kuo and Lu (2013) stated that the CFPR and AHP approach not only assesses overall project risk, but its concept can also be used to evaluate the risk of a series of work items when detailed ranked construct of risk factors for the project is established. Some of the constructs can be mathematical. Mathematical theory derives from quantitative methods. Kuo and Lu found that human experience and instinct, which are qualitative methods, are appropriate for the solution of such problems. Chang et al. found that the model of ZOGP is suitable for collecting stakeholder opinions while reducing decision bias. In essence, all the procedures yielded accurate weights for building method determination for diverse green building projects.

Fazli, Mavi, and Vosooghidizaji (2015) proposed a framework that used ANP and DEMATEL to address the relationships between practical crude oil supply chains

systems. Fazli et al. used ANP to analyze the dependence characteristics and used DEMATEL to determine the connected associations among the uncertain criteria. Banaitienė et al. (2015) used a modified fuzzy ANP and DEMATEL model to deal with creating leisure space in blighted neighborhoods. The modified DEMATEL captured the relationship and divided the criteria into two groups: the root group and the outcome group. The root group has an influence on the outcome group, and possible influence to approximate the criteria weights. Fazli et al. found that ANP and DEMATEL are the most appropriate tools where the goal is to understand the hierarchically interconnected relationships, as well as the cause and effect. DEMATEL is a mathematical, computational method that can convert the relations between the causes and impacts of criteria into a visual structural model (Fazli et al.). Moreover, DEMATEL can be a valuable method when one needs to process the inner needs within a set of criteria.

The main advantage of DEMATEL is that its use involves secondary relationships within a cause and effect model. Fazli et al. (2015) found that the DEMATEL method is an effective way of examining structure and relationships between crude oil supply mechanisms. Evaluators can use DEMATAEL to prioritize the criteria based on the type of relationships and difficulty of impacts they have on one another. In conclusion, Banaitienė et al. (2015) observed that DEMATEL is suitable to deal with linguistic and fuzzy evaluations with no need to determine the criteria weights. DEMATEL clarified the functional relationships between the measures and converted these connections into a viable fundamental model (Fazli et al.). Using the viable model provided ease in capturing the core of the problem with the rigorous criteria weights; consequently,

efficient decisions are possible (Banaitienė et al.). Moreover, comparing the alternatives by using the weights introduced in the DEMATEL method provides a comparable, standardized gauge that differs from weights that measure fuzzy assessments (Fazli et al., 2015). Finally, DEMATEL can be easily adjusted and applied to different decision–making problems, such as manufacturing, environmental engineering, financial analysis, social science, and material selection (Banaitienė et al., 2015).

Life cost analysis. Life cycle assessment is a tool available to businesses for environmental decision making when remediating contaminated sites (Chen, Fan, Ko, & Liu, 2012). Since the beginning of the 21st century, the importance of a more holistic approach to the management of contaminated land has received acknowledgement (Cappuyns & Kessen, 2014). Soil remediation expertise is an important factor in the elimination of contaminated sites, and the applicability of the remediation method is a critical factor affecting the efficiency, cost, and management of site remediation (Bai et al., 2014).

Seeking to do decision–making research as decision making pertains to soil and groundwater remediation technologies, Bjerg, Lemming, Hauschild, and Owsianiak (2013) conducted literature reviews of researchers who used the life cycle assessment (LCA) tool. Cho et al. (2016) did a study to determine whether life cycle assessment improved decision making in contaminated sediment remediation. Bjerg et al. (2013) researched life cycle assessment when making decisions dealing with soil remediation as well. Exploring site remediation using LCA promotes contemplation of broader impacts (Bjerg et al.). Cho et al. compared three alternatives, including two conventional

methods, dredge–and–fill and capping, and an innovative sediment treatment technique, in–situ activated carbon (AC) amendment.

Bjerg et al. (2013) used LCA to compare the environmental impacts of different remediation scenarios. Even though LCA offers valuable information to support risk–management decisions in soil sediment remediation, neither takes into account issues (cost, technical aspects, and the land use after remediation) that are significant in the selection of residue management alternatives (Cho et al., 2016). Remediation of a contaminated site can reduce environmental problems; however, at the same time, the remediation activities may cause adverse environmental impacts on a global scale (Bjerg et al., 2013). Cho et al. (2016) stated that one way to include all of these factors is to integrate life cycle assessment with other MCDAs to produce a tertiary effect in one model.

Evaluators use LCA tools to evaluate the trade–offs in remediation alternatives regarding environmental problems. The final choice of alternative depends on the priorities of the decision maker (Lapinskiene & Martinaitis, 2013). Berg et al. (2013) evaluated the LCA methodologies of 31 reviewed studies with particular emphasis on objective and scope, classification, and the related effect on the assessment. The 31 studies varied in fundamental methods, since some focused on the current decision support while others focused on the completed remediation project. Berg et al. showed that numerous studies have employed LCA of site remediation options and that the tool is suitable for decision support within environmental remediation (Bjerg et al.). Although the aim of the research was to study soil and ground water remediation, the majority of

the reviewed research focused exclusively on contaminated sites. Focusing on soil contamination problems does not address the impact of contaminating the groundwater (or related surface water bodies) when evaluating the impacts of residual contamination (Bjerg et al.).

In contrast, Binning et al. (2012) did a study on LCA methods using in–situ chemical oxidation (ISCO) and proposed models focusing on decisions and expectations of the LCA application to site remediation activities. Binning et al. found that LCA was not suitable for decision making when using ISCO. The authors concluded that LCA has limitations as an adequate decision–making tool, since spatial and earthly differences in nonuniversal impact assessments cause problems in site remediation. Binning et al.'s findings can omit the LCA tools when using ISCO as methods for site remediation decision making. Since the environmental effects of the postremediation stages of sites are not part of existing site remediation LCA research, such exclusion may produce misinformed conclusions and misdirected decision making. LCA studies can efficiently inform the decision making of multiple stakeholders with contradictory and theoretically inconsistent viewpoints and goals (Pesonen, Swarr, & Zamagni, 2013).

Sustainability

Sustainable advancement has become a principle that all governments seemingly desire to acknowledge (Aguilera-Caracuel, Morales-Raya, & Ortiz-de-Mandojana, 2014; Bond, Morrison–Saunders, & Pope, (2012). Organizations around the world are progressively considering environmental and social demands as they strive to achieve success beyond financial returns (Fairfield & Harmon, 2014). Lee, Peng, Wang, and Wu

(2013) stated that a district's sustainable growth should focus not only on demolition and construction, but also on local values and revitalization. Various agencies, remediation engineers, and other stakeholders (Zhang, 2013) are increasingly recognizing GR (Hashemi, Karimi, & Tavana, 2015; Lubrecht, 2012). Al–Tabbaa and Hou (2014) reviewed existing theories and empirical evidence on using sustainable GR in decision making by management. Hashemi et al.) conducted a case study using both economic and environmental criteria, and they proposed a comprehensive green supplier selection model.

To perform a sustainability assessment of a project's life cycle, one must value costs presented by environmental, economic, and community impacts (Lee et al., 2013). Al–Tabbaa and Hou (2014) concluded that sustainability is becoming a new imperative in the environmental remediation field, with important implications for regulators, liability owners, consultants, contractors, and technology vendors, and that should be part of management's decision making because the industry is expecting sustainable remediation. Hashemi et al.'s (2015) approach allowed decision makers to participate in the assessment process and use linguistic evaluation in the green supplier selection process, which caused some limitations in the findings of the study. GR employs best management practices and Zhang (2013) argued that traditional cleanup technologies are facing a paradigm shift from cost effectiveness to more holistic approaches, which include economic, social, and environmental impacts. Although Hashemi et al. agreed with Zhang's thinking, and although dependence on stakeholder opinions limited the study which used the AHP criteria, they did find that the approach was flexible and useful

for application in a broad range of managerial and decision–making environments. Al–Tabbaa and Hou (2014) argued for a comprehensive and accommodating framework for integrating sustainability values such as GR into remediation decision–making processes. The sustainable remediation forum (SURF), which is a group of remediation professionals from industry, government, and academia, strived to develop a framework.

Al–Tabbaa and Hou's (2014) framework incorporated a sustainability approach throughout a project's lifespan. Kerrison and Smith (2013) discussed a benchmarking exercise to evaluate possible disparities in environmental management decision making. This exercise derived from applying different sustainability tools (qualitative and quantitative) outlined in the sustainable remediation forum United Kingdom (SURF–UK) framework. Al–Tabbaa and Hou's framework attribute began with the final project objective in mind. For example, knowing how a remediation site will be used at the end of the project in the early stages of decision making helps environmental professionals form a well–organized strategy, thereby avoiding activities that can affect the project negatively.

Remedial alternatives for risk management of subsurface petroleum release used Kerrison and Smith's (2013) assessment tools. Dealing with subsurface petroleum release could require very technical assessment tools (Doberl, Fruhwirth, & Ortmann, 2012). The exercise showed that the same sustainability assessment tools used for a simple remediation project also worked in the same remediation option for more complex assessments of land contamination projects (Kerrison & Smith, 2013). Land contamination is a major challenge to society, with an estimated 294,000 contaminated

sites in the United States (Al–Tabbaa, Hou, & Luo, 2014; EPA, 2013). Al–Tabbaa and Hou's (2014) thought process could stop the demolition of contaminated buildings and possibly offer renovation saving a great deal of money. Al–Tabbaa and Hou's continual use of the SURF framework and Kerrison and Smith's use of SURF–UK can lead to environmental remediation projects with improved environmental, economic, and social performance qualities that will help all stakeholders in the future.

Doberl et al. (2012) conducted a study to establish a sustainability assessment goal that supports decision making in contaminated site management. Bartke, Finkel, Morio, and Schadler (2012) developed a sustainability assessment model and presented a case study that evaluated redevelopment options for large contaminated brownfields. Doberl et al.'s assessment tool helped in employing the values of sustainability in the selection of remediation alternatives in Austria. The basis of this technique is the principle of a cost effectiveness analysis. The cost effectiveness analysis allows for an assessment of environmental, socio–economic, and technology–related effects of remediation options (Doberl et al.). Bartke et al.'s model, which aimed to support sustainable revitalization and communication between stakeholders, incorporated three points of brownfield revitalization: underground remediation and site development cost, cost–effective appraisal, and intended future land redevelopment. Doberl et al. used a modified cost–effectiveness analysis (MCEA) to assess the environmental–economic effect of different waste management opportunities. Bartke et al.'s spatial decision support systems model showed that even when brownfield redevelopment is sustainable, additional contributions to sustainability do not necessarily lead to increased cost. Doberl

et al. found, among other things that dealing with uncertainties was a fundamental concern regarding the reliability of the results of the study. The MCEA method proved that implementing the principles of sustainability in decision making on remediation alternatives could also standardize the assessment of environmental, economic, and social impacts of remediation (Doberl et al.).

Figge, Hahn, Pinkse, and Preuss, (2014) articulated three dimensions to sustainability: economic sustainability, environmental sustainability, and social sustainability in meeting the needs of stakeholders. Grosvold, Hoejmose, and Roehrich (2014) used theory building to conduct a cross–sectional study of the decision–making process involved in sustainable supply chain management. Figge et al. found that to achieve long–term sustainability, businesses would have to manage not only economic resources, but also natural and social resources. Grosvold, Hoejmose, and Roehrich identified environmental situations that help explain the decisions that organizations make when dealing with trade–offs among the economic, environmental, and social elements of the triple bottom line. Figge et al. found that determining social, economic, and environmental advantage is more difficult because one needs to know how to determine how best to bring the change into line. Grosvold et al. found that as organizations make decisions about the trade–offs between profits and environmental concerns, the organizations' decisions provide the opportunity to think about and create new products and methods that can establish new business opportunities and long–term competitive advantages.

In summary, Bates, Linkov, Madison, and Tsang (2014) stated a need for a decision directed approach such as MCDA, specifically the life cycle assessment method, in risk management of emerging threats (see Appendix B). As stated earlier, MCDA refers to a collection of methods used to enhance understanding of a complex and uncertain decision–making processes. Generally, the MCDA process consists of four steps: (a) structuring the problem by identifying criteria through stakeholder elicitation and assessment of the different criteria that are relevant to the given decision; (b) eliciting the parameters of the model, such as alternatives, decision criteria, relative weights, and preference thresholds, and evaluating the performance of each alternative on each criterion; (c) applying a decision algorithm that ranks each alternative from most to least preferred; and (d) interpreting results of the model and reiterating the process from Step 1 or 2 by re–evaluating the model (Bates, Linkov, Madison, & Tsang 2014; Linkov & Seager, 2011).

Decision procedures are the centerpiece of MCDA, with many different types to select from, including but not limited to AHP, ANP, DEMATAL, ELECTRE, MAUT, life cost analysis, PROMETHEE, and SMART (see Appendix B). MCDA helps establish data for decisions that involve multiple points of view (i.e., differences of opinion between different decision makers or stakeholders) or that require assessment of tradeoffs among several criteria that are not reducible to one ideal result. Although MCDA can be used when uncertainty is prominent, MCDA requires that alternatives and decision criteria be identified at the beginning (Linkov & Seager, 2011).

Transition

In summary, MCDM and MCDA techniques are useful at various stages of project selection, such as VS, techniques used to handle remediation projects, stakeholder preferences, and determining the form of sustainability efforts. Hsu et al. (2012) stated that MCDM and MCDA are useful in practical decision–making problems, such as project assortment, supply chain management, and optimal planning problems. Chai et al. (2013) added that MCDM and MCDA are useful in four aspects of the process: decision difficulties, decision makers, decision conditions, and decision methodologies. Finally, Kuo and Lu (2013) found that MCDM and MCDA could use quantitative methods that involve statistical theories as well as qualitative methods that use human experiences and instincts. Well–defined descriptions of approaches beneficial to environmental project selection are important to this topic of study. The current research may create an essential link between theory and practical application of MCDM and MCDA in brownfield remediation projects.

In Section 2, I will detail the qualitative methodology and case study design that I used in this study. I used a qualitative methodology to explore patterns that created meaning and themes from a specific phenomenon (Moustakas, 1994). I used a case study design because case study data analysis is a methodical approach for exploring human trends (Moustakas, 1994). I explored the decision–making processes currently used by environmental engineers to evaluate the feasibility of environmental restoration and remediation projects. In Section 3, I will provide the results of the data collection, and ultimately, the study. By adding the results of this study to the literature in the field, the

engineering business community will have additional knowledge and a process to follow when dealing with project management.

Section 2: The Project

This section provides an explanation of the approach of the study and the rationale for using the selected methodology. The research methodology and design are a qualitative single case study approach. Additionally, Section 2 includes a restated purpose statement, role of the researcher, participants, population and sampling, and ethical research. Furthermore, Section 2 contains data collection, data analysis techniques, and reliability and validity. The purpose of this study was to find effective decision–making strategies that help environmental engineers acquire profitable environmental redevelopment projects. I interviewed four environmental engineers in Camden County, New Jersey, to obtain in–depth information about the phenomenon using a qualitative single case study approach.

Purpose Statement

The purpose of this qualitative, exploratory case study was to find effective decision–making strategies that help environmental engineers acquire profitable environmental redevelopment projects. Using a single case study approach allowed the in–depth focus required for me to understand the acquisition efforts of one environmental remediation engineering firm in Camden County, New Jersey. For this qualitative study, the data gathering method included documentation review (internal documents such as in–house information bulletins, environmental declarations, annual reports for the current year, as well as external sources such as press releases, web pages, trade registries). I also conducted open–ended semistructured interviews with environmental engineers and the acquisition team who have decision–making responsibility. This triangulation technique

provided a stronger validation of the results (Yin, 2014). I continued to use the triangulation technique until saturation. Pearsall (2013) took this approach and conducted a single case study focusing on redevelopment and gentrification of contaminated sites in New York using 18 semistructured interviews. The results of this study can benefit and contribute to positive social change by providing all stakeholders, including the environmental remediation engineering community, better decision–making processes that may comprise sustainability efforts. Furthermore, the data from this study may provide opportunities for environment organizations to teach and train stakeholders on environmental processes while providing profit opportunities to shareholders through sustainable practices.

Role of the Researcher

My role as the researcher started with having expertise in receiving requests for proposals and evaluating engineering firms' responses to remediation projects for a governmental entity. My relationship with the governmental entity provided for a preexisting relationship with the engineering firm that I used for this study. I also reviewed the literature, case studies, and current trends pertinent to the topic to gain a greater perception of the research subject. In preparing for this case study, I reviewed the literature on the topics of brownfield redevelopment projects, environmental cleanup, understanding of MCDM and MCDA, uncertainty in environmental decision making, AHP, DEMATEL and ANP, life cost analysis, and assessment of sustainability in environmental decision making. In reviewing the literature, I found evidence that a

qualitative study depends on the researcher's observation and analytical ability (Moustakas, 1994).

According to the American Psychological Association (2010), three established principles in preparing ethical research are to confirm the truthfulness of scientific information, to protect the rights and well–being of research participants, and to safeguard intellectual property entitlements. The U.S. Department of Health and Human Services (2014) also guides research using three ethical principles taken from the Belmont Report Protocol: respect for persons, beneficence, and justice. With this in mind, to demonstrate and offer ethical considerations to participants and show that ethics were of great importance in this research project, I completed Human Research Protections training on June 26, 2011.

Furthermore, I used written informed consent, which offered respect for persons to decide what will or will not happen to them (Bell & Bryman, 2007; Yin, 2014). Included in the written informed consent was a statement that affirmed that I would maintain the data in a safe place for 5 years (National Institutes of Health Office of Extramural Research, 2014). I did not use names of individuals or organizations in order to protect the rights of the participants or research (Bell & Bryman, 2011). I also informed the participants of who receives the benefits of this research, as well as who bears the burdens (National Institutes of Health Office of Extramural Research, 2014). Participants were able to withdraw from participation by giving written or verbal notice. The research project was of mutual benefit to the researcher and the subjects involved in the research (Bell & Bryman, 2011; Yin, 2014). Each of these ethical considerations

upholds the established principles of ensuring the accuracy of scientific knowledge, protecting the rights and welfare of research participants, and protecting intellectual property rights (American Psychological Association, 2010; U.S. Department of Health and Human Services, 2014).

Researcher bias can affect the direction or outcome of case study research (Yin, 2014). For this study, I had direct contact with the participants. Having direct contact by using face–to–face interviews may seem to be a more subjective form of data collection than other qualitative methods incorporating other modes of data collection, such as questionnaires (Drew, Irvine, & Sainsbury, 2013; Ritchie, Lewis, Nicholls, & Ormston, 2013). To mitigate bias and avoid viewing data through a personal lens, I relied on data rather than merely on my own judgment. I did not interject my personal ideals or thoughts into the interviews or data collection. I remained focused on the data collection, process, information, and outcomes while exercising common sense.

Yin (2014) suggested that the interview protocol instrument (see Appendix C), which I used in this case study, should use not only open–ended questions, but also contain subquestions to elicit more descriptive information. Interviews lead to a high success rate if researchers schedule the interviews in advance (Creswell & Tashakkori, Yin) I audiotaped the interviews, coded the data, and followed the protocol of Yin. Yin maintained that one–on–one interviews do not protect the anonymity of the participants, as a questionnaire would. Therefore, accuracy in the transcription of audiotaped interviews and coding of data, with the permission of the interviewee, reduces the danger

of breaches in confidentiality and protects the participants being interviewed as the interview is recorded (Yin, 2014).

Participants

The participants aligned with the nature of the study, as they discussed their individual experiences and opinions about how the company makes decisions regarding project management. The focus of the interview questions was decision–making practices. The selection criteria for the company I chose included: (a) size, (b) presence of a environmental remediation department, (c) geographical accessibility to myself, and (d) evidence through documented instances that the company managers have proven decision–making strategies that acquired profitable environmental redevelopment projects in the past 5 years.

Using a single case study approach allowed the in–depth focus required for me to understand the acquisition efforts of one environmental remediation engineering firm in Camden County, New Jersey. I first researched the population of firms that I had done business with in my previous position in government that met the above criteria and narrowed down the participation to one firm. I then addressed the total number of potential interviewees within the case setting. My experience in dealing with these firms and their acquisition teams allowed for a maximum of eight interviewees and a minimum of three interviewees.

As this was a Walden University doctoral study (Camacho, 2012), prior to initiating research, the managing partners of the engineering firm executed consent forms (see Appendix D) that granted me direct access to all employees, internal documents, and

active and inactive request for proposals for site remediation or redevelopment projects. Merriam (1988) noted that researchers observe events and sites and conduct interviews. Leedy and Ormrod (2013) stated that in purposeful sampling, the researcher uses his or her judgment to select participants based on the proposed study criteria. Purposeful sampling has the goal of ensuring that the sample will produce the most relevant and significant data to address the research question (Anders, 2015).

Purposeful sampling allows recruitment from a specific population to gain the greatest amount of data. Researchers design purposeful sampling criteria by creating a list of attributes essential to the study and locating participants within the target population who will meet the criteria (Bhaumik, Duan, Hoagwood, & Palinkas, 2014). I selected a purposeful sample for this study taking into account the need for intimate knowledge of the daily operations and the latitude to make managerial decisions (Camacho, 2012). Selection criteria included: (a) job assignment, (b) role within the organization, and (c) knowledge of company operational methods. In addition, participants must have been involved in decisions on environmental projects within the last 5 years. Furthermore, I asked participants to provide insight into and information about the current decision–making practices of the engineering firm. I protected the identity of the participants and the organization.

According to Yilmaz (2013), the number of participants should be adequate to ensure saturation, which could occur with a small pool of participants with experience in or with the phenomenon. Snowball sampling involves seeking information from participants about other people who could add knowledge to the study (Anders, 2015;

Merriam, 2014). As participants who were interviewed mentioned names of other people who might provide useful information, I offered a request to those people to participate in the study. This continued until no new names emerged (Choong, Dunn, Galgani, & Tsafnat, 2014; Patton, 2002). For this qualitative study, the data gathering method was to seek a minimum of three environmental engineering personnel. These personnel represented the company's acquisition, quality, and project management teams. I continued to interview the environmental engineers and other personnel within the company, which ended up being 4 interviews as no new information emerged.

For this qualitative study, I used a triangulation technique to gather the data. I used semistructured internviews as well as internal documents such as in–house information bulletins, environmental declarations, annual reports for the current year, as well as external sources such as press releases, web pages, trade registries). This triangulation technique provided a stronger validation of the results (Yin, 2014). I continued to use the triangulation technique until saturation. Pearsall (2013) took this approach and conducted a single case study focusing on redevelopment and gentrification of contaminated sites in New York using 18 semistructured interviews.

I saved all collected data from participants on a secured hard drive and will keep the data for 5 years after conducting the study. I will destroy all research data after 5 years. I did not offer compensation to participants. The participants had the right not to answer any questions and to withdraw from the research study at any time. As noted earlier, I gained consent to interview any personnel in the organization (see Appendix D) from the principal owners. I also issued a summary of the project to all potential

participants, who were required to execute an informed consent to participate in the project (Camacho, 2012).

Research Method and Design

The research methodology for this study was a qualitative case study design. I selected this research design based on the nature of my topic, which was how environmental engineers make decisions on project selection can enhance the acquisition of environmental remediation and redevelopment projects. Given the importance of managerial decision making, the qualitative methodology was the best fit for the research topic as I will explain in the following subsection.

Research Method

In this study, I used a qualitative research method with a case study design. Using a qualitative method allows a researcher to explore patterns that can lead to the development of meanings and themes regarding a specific phenomenon (Bell & Bryman, 2011; Marshall & Rossman, 2014; Moustakas, 1994). According to Bell and Bryman (2011), qualitative research involves questionnaires and interviews that elicit participants' responses. Researchers use qualitative methods for exploratory studies when interpreting a phenomenon and when themes will describe the data; the researcher can then make declarations based on the information collected (Bell & Bryman, 2011). Furthermore, according to Marshall and Rossman (2014), qualitative research is realistic, interpretive, and grounded in people's experience. A qualitative method suited this study because the research question reflected an exploratory inquiry focusing on the decision–making

processes used by environmental engineers in the environmental remediation industry that builds organizational sustainability at the acquisition department level.

Quantitative and mixed methods research did not provide appropriate methodologies for the study. Quantitative research has a base in statistics, defines the relationship between data and observation, and is dependent upon identified variables (Doherty, 2011; Leedy & Ormrod, 2013; Marshall & Rossman, 2014). Since I did not using statistics and identified variables a quantitative method was not appropriate for this research. Furthermore, a quantitative method did not suit this study because I did not perform a statistical analysis of numerical data (Leedy & Ormrod). In turn, a mixed methods study involves combining quantitative research and the practical aspects of qualitative research methods into a single study (Leedy & Ormrod). The study did not meet the description of a mixed methods study. Mixed methods research includes the collection, analysis, and mixing of both closed–ended quantitative and open–ended qualitative data (Halcomb & Hickman, 2015). Combining qualitative and quantitative data into one data set was not a necessity in this case. Leedy and Ormrod stated that combining qualitative and quantitative data into one data set is not essential.

Research Design

I considered five approaches for this study: phenomenology, ethnography, grounded theory, narrative, and case study. Researchers have used the case study method to gain insight into business practices and to understand particular phenomena manifested within specific organizations (Yin, 2014). Case study design allows for in–depth descriptions that focus on understanding relevant elements of the case within the scope of

the respective environment (Casey, Houghton, Murphy, & Shaw, 2013; Dowlatshahi, 2010). Yin noted that the case study design allows investigators to address research questions that focus on contemporary issues to determine the how and why of the phenomena of interest. I explored the viewpoint and the experiences of the participants and elected to use a qualitative case study design.

According to Marshall and Rossman (2014), a phenomenological approach addresses the perspectives and lived experiences of the participants. I did not select a phenomenological approach because the number of participants was small and could not satisfy the requirements of the phenomenological approach. Ethnography was another possible design for the research topic. According to Leedy and Ormrod (2013) and Strider (2013), ethnographic research requires intensive fieldwork, including the direct observation of participants over time. In addition, an ethnographer should engage in the culture (Leedy & Ormrod). I did not study a culture or ethnic group, but rather events, programs, and individuals, and therefore, ethnography was not an appropriate design. In grounded research, a researcher dissects the element of experience of a specific group in a specific setting (Biraghi, Gambetti, & Graffigna, 2012). I did not intend to build theory, and thus grounded theory was not appropriate for this study. Narrative research involves looking at an agency as a property of social processes and exploring ongoing associations between individuals and events (Barkhuizen, 2014; Cachia & Millward, 2011; Garud & Giuliani, 2013; Spector–Mersel, 2010; Strider, 2013). A narrative design did not align with this study.

A qualitative case study approach was the most advantageous design for this study. The case study approach reflects the exploration of a problem in an attempt to understand several decisions, as well as the motives and implementations of these decisions (Yin, 2014). Bjerg et al. (2013) did a case study using life cycle analysis to understand and implement different remediation technologies. Laudal (2011) used a qualitative case study approach to understand the internationalization process of businesses in emerging markets. Cappuyns et al. (2012) conducted a case study to design a framework that addresses how to remediate aquatic sediments contaminated with heavy metals originating from mining and metallurgical activities. Li, Liu, and Wu (2012) did a case study to identify and evaluate the environmental effects of biofuel production in a Midwestern United States river basin. I used a qualitative case study approach to explore the decision–making processes used by environmental engineers in the environmental remediation industry.

Population and Sampling

For this qualitative study, the data gathering method was to use multiple sources of documentation review (internal documents such as in–house information bulletins, environmental declarations, annual reports for the current year, as well as external sources such as press releases, web pages, trade registries). I also use open–ended, semistructured interviews to interview environmental engineers and the acquisition teams who had decision–making responsibility. The participants of the study represented the company's acquisition, quality, or project management teams and environmental

engineers, as well as any other identified participants referred to me that met the case study criteria.

Using purposeful sampling assisted in focusing on credible information from participants for an in–depth study to answer the research question (Duan et al., 2013; Sokolowski, 2008). Purposive sampling also allows for studying a group of people that is representative of a subset of a larger population, and this approach serves a specific fact–gathering need (Yin, 2014). Some employees did not meet the criteria and therefore I did not select them to be a part of the interview group. Patton (1990) proposed that purposive sampling allows researchers to select participants based on established criteria. The criteria for this current study included: (a) job assignment, (b) role within the organization, (c) knowledge of company operational methods, and (d) involvement in making decisions on environmental projects within the last 5 years. Purposeful sampling allows for in–depth, qualitative examination of small groups of participants (Choong et al., 2014; Patton, 2002), which was the best approach for this research. Qualitative methods allow for in–depth sampling of small groups to understand a process or phenomenon (Dworkin, 2012; O'Reilly & Parker, 2013). In contrast, quantitative sampling methods require large numbers of participants to ensure statistical significance.

According to Yilmaz (2013), the number of participants should be adequate to ensure saturation. I used the snowball method by asking the participants to assist in identifying other potential subjects to ensure that saturation occurs. For this qualitative study, the data–gathering method was to seek environmental engineering personnel and the acquisition team that met the participant criteria. I used the snowball method after

using purposeful sampling by asking the participants to assist in identifying other potential interviewees, and I continued interviewing, analysis, and member checking until I reached data saturation, which occurred after 4 interviews. I understood that sampling by itself was not enough to assure data saturation. The proof was in the data when no new themes emerged.

Ethical Research

Scholarly research rests upon the researchers' ethical actions. I considered and employed ethical issues when collecting data from participants. To make certain that I met the acceptable standards and practices (Brehaut et al., 2015), I explained all aspects of the study process to the participants. Each participant signed a consent form before participating in the interview. The consent form included information informing the participant about the research topic, risks, and benefits of being in the study. According to Bell and Bryman (2011), researchers must protect the privacy of the research subject. I walked through the consent form with each participant to confirm his or her understanding and clarified any questions. I held the interviews at the participant site in a conference room, which ensured privacy, which allowed participants to speak freely. Participation in this study was voluntary and participants could withdraw from the study at any time. If the participant elected to withdraw from the study, I provided the participant with the interview notes and the audio recording to destroy. The participants of this study did not receive any compensation for their participation. I provided a copy of the interview notes and recordings to the participants for review prior to analyzing the data, and after the completion of my doctoral study, I sent the participants a summary of

the results. All collected data will remain in a password–protected external hard drive for 5 years before disposal. The participants' identities are confidential. Each participant received a unique number to maintain confidentiality. I received permission from the institutional review board (IRB), obtaining IRB approval number 11–16–16–0155960 before commencing interviews and conducted the study under IRB approval from Walden University.

Data Collection Instruments

Data collection and analysis are the foundations of a research study. According to Moustakas (1994), data collection centers on the topic under study by using open–ended interview questions. The data collection section for this study comprises three areas: instruments, data collection technique, and data organization technique. The instrument includes the name and type of the device used in this study. The data collection and organization techniques include the collection of the data through interviews and the organization of the collected data for analysis.

Case study evidence can come from six sources: documentation, archival records, interviews, direct observations, participant observations, and physical artifacts (Yin, 2014). The data collection instrument for this study included not only myself as the primary data collector, but also interview notes, audio recordings, internal documents, such as in–house information bulletins, environmental declarations, annual reports for the current year, as well as external sources such as press releases, web pages, and trade registries. The use of semistructured interviews can lead to understanding the decision–making process that the environmental engineer and acquisition team use for project

selection (Moustakas, 1994). I ensured reliability and validity through examining the consistency of the responses noted in the interview notes along with a member–checking technique and data triangulation (Chenail, 2012). Doing this assessment can invoke in–depth responses from the participants' experiences (Yin, 2014). My interview protocol consisted of the following: (a) starting with my script, (b) collecting consent, (c) arranging interview location, (d) audio recording interview and taking brief notes to verify accuracy, (e) keeping focused, and (f) ending with the script. I interviewed participants at a location that suited participant comfort and ensured privacy, which allowed participants to speak freely. Additionally, I used internal documents regarding the engineering firm that correlated with the interview data to increase my understanding of the participants' responses during the interview process.

Data Collection Technique

The data collection techniques for this study was conducted usind a triagulation technique that included semistrucuted inteviews. Yin (2014) suggested three types of interviews for a case study design: in–depth interviews, focused interviews, and formal surveys. Dourson et al. (2013) used in–depth interviews in a case study to understand the importance of problem formulations in risk assessment involving dioxin–contaminated soil. Grosvold, Hoejmose, and Roehrich (2014) used in–depth interviews to explore how organizations balance short–term profitability and long–term environmental sustainability when making decisions under conditions of uncertainty.

I used open–ended, semistructured interviews with environmental engineers and their acquisition teams who have decision–making responsibility. Semistructured face–

to–face interviews provide an approach to exploring how environmental engineers and their acquisition teams make decisions on project selection. The advantage of this type of interview is that the semistructured format can make the participants feel comfortable with sharing their experiences while answering the interview questions (Rubin & Rubin, 2012). Pearsall (2013) used semistructured interviews to understand how a community worked together to stop the gentrification of a town in New York City.

Ehrenhard, Muntslag, and Wilderom (2012) used documentary research and semistructured interviews to explore whether management control systems have a role in implementing sustainable strategies. Anyan (2013) stated that semistructured interviews work well as an interview technique. Seeking MCDM processes, I used in–depth semistructured interviews to study how environmental engineers select projects. Yin (2014) stated that using semistructured interviews provides the researcher with a much longer period of probing. I structured the interviews to last approximately 45 minutes. The advantage of this strategy is that the participants could get through the interview questions following the interview protocol (Yin, 2014) and not get tired and try to rush through the interview questions.

The first step in conducting the interviews was to create a list of the potential participants from the engineering firm, and then contact the participants and explain the purpose of the study and the potential social impact. At the agreed–upon time and location, I presented the list of questions along with the consent form to each participant. To obtain accurate in–depth answers, informal conversations followed the formal interview. Utilizing member checking, multiple interviews with participants, and follow–

up conversations that allowed for additional information helped in confirming the understanding of the participant's answers. In addition to reading the online web information regarding the engineering firm's business philosophies, I correlated that information with the interview data. Correlating the information can lead to a better understanding of the participants' responses to the interview questions. I used member checking and follow–up interviews with participants to gain further understanding of the participants' perspectives (Chenail, 2012; Denzin, 2012; Moustakas, 1994).

The study did not require a pilot study. A pilot study consists of studying members of a population to determine the appropriateness of the interview questions and to establish the time, cost, and feasibility of a new data collection instrument (Elmslie, Grinde, & Shea, 2011; Germer & Neff, 2013). I employed a set of interview questions developed by Strider (2013) to understand what decision–making strategies environmental engineers use to facilitate the acquisition of profitable environmental redevelopment projects. Strider's questions captured knowledge of business leaders about aspects of ethical decision making. The questions used in Strider's study examined how business leaders establish, create, and utilize values. The results of Strider's study offered members of the business community an understanding of how business leaders made decisions. The interview questions are reproducible and I have adapted Strider's questions to fit this study. Strider approved the use of the revised questions (see Appendix E). Furthermore, for this study, I sent out my interview questions for peer review and incorporated the feedback before IRB approval. This technique helped to ensure that the questions I asked brought forth robust information to analyze and

ultimately to help the environmental engineering community. The peers for the review of the interview questions were other engineering firms' environmental engineer managers with whom I have personal relationships. This approach is consistent with peer–reviewed articles (Alvarez, Espasa, Guasch, & Kirschner, 2013; Carless, Lam, Salter, & Yang, 2011).

Data Organization Technique

I organized data using NVivo. I added the interview transcriptions (Yin, 2014) to an NVivoaccount, and then used NVivoto categorize the data by theme. Other Walden studies have used these tools successfully (Bouges, 2013). I hired an assistant who has expertise with NVivo. The assistant signed a confidentiality agreement (see Appendix F). I used NVivo to assist in the organization of the interview transcripts and notes. Moreover, NVivowas beneficial in allowing me to code and examine the data. Organizing the data this way assisted individuals in organizations who will be reviewing the data to understand how they can apply the results to their organizations (Kuglitsch, 2015).

To safeguard privacy during data collection, all documents, including interview notes, audio recordings, internal documents such as in–house information bulletins, environmental declarations, annual reports for the current year, as well as external sources such as press releases, web pages, and trade registries, and consent forms, will remain on a secure hard drive for 5 years with a secured backup on another hard drive. All data was password protected and saved on a secure hard drive. I will keep all data for 5 years after conducting the study. I will destroy all research data after 5 years.

Data Analysis

Analysis for this study hinged on rich data using triangulation. Four types of triangulation exist: investigator, theory, methodological, and data triangulation (Denzin, 2012; Moustakas, 1994). I used data triangulation for this study. Triangulation using multiple sources of information to form themes and patterns strengthens the validity of the study (Denzin, 2012; Frels & Onwuegbuzie, 2013; Moustakas, 1994). Triangulation for this study included interviews and audio recordings with environmental engineers and their employees, direct observation (visits to the facilities and contact with employees), and access to internal documents (in–house information bulletins, environmental declarations, annual reports for the current year.), as well as external sources (press, web pages, trade registries). This triangulation technique provides a stronger validation of the results if they converge (Yin, 2014). After the data collection from the interviews and the online sites, I began analyzing the data using NVivo, a data analysis program. Each participant had a unique numerical code to maintain his or her confidentiality. After defining the themes, I compared and contrasted the responses of the participants. After the collection of data, I used the coding process to break the data into segments. Developing a coding scheme was the first step of the analysis (Lewis, 2015; Saldana, 2011). I developed a coding construct to streamline the analysis of the data and then assigned the codes for the overall themes of the data.

Data Coding

Coding qualitative data refers to the process of combining the data into categories, themes, and ideas (Zamawe, 2015). Qualitative data analysis involves gradual, repetitive

cycles that can take the researcher back to a previous step, but throughout the process, patterns and themes emerge. From these themes, researchers build concepts and theories (Lewis, 2015; Saldana, 2011).

In this study, I codified the qualitative data by coding and recoding the words and phrases (Drakopoulou, McDonald, McElwee, & Smith, 2013; Kikooma, 2010). NVivowas beneficial in allowing me to code, examine, and store the data (Zamawe, 2015). A necessary exploratory step in data analysis coding involves the classification and connection of the data (Saldana, 2011). During the coding process, I grouped the data into emerging categories, patterns, and themes (Lewis, 2015), and developed a schematic chart of categories and subcategories congruent with the research question, interview questions, and problem statement (Saldana, 2011).

Saldana (2011) identified three primary coding methods (initial coding, axial coding, and theoretical coding) that comprise the coding canon and can guide researchers in the identification of patterns and themes. I performed initial coding during the first cycle of coding (Lewis, 2015). Initial coding relates to open coding, and Saldana posited that initial coding should serve as a starting point and provide a researcher with guidance for the direction of a study and further exploration. The initial coding process involves breaking down large quantities of qualitative data into smaller, discrete parts (Saldana, 2011). The categorization of recurring data occurs in the initial phase.

Data Analysis Consistency

The research question for the study was: What are the decision–making processes used by environmental engineers to help with the acquisition of profitable environmental

redevelopment projects? I presented data analysis results that aligned with the research question. Encountering data that are relevant but not perfectly aligned with the research question can occur in data collection and I put these data in a research notebook for future reference if needed. Using a constructivist lens allowed me to focus on key themes and correlate these themes with the literature, including new studies published since the start of my study. According to Marshall and Rossman (2014), a researcher should have a good understanding of previous research, but remain open to possible emerging theories that would require examination of additional literature during the study. The themes derived from this study represented my interpretation of the data (Bondas, Turunen, & Vaismoradi, 2013; Lewis, 2015). The interview questions guided the organization of the data interpretation. The explanations consisted of the research results and my conclusions. I disseminated the results of this study to the study participants and the owners of the engineering company, along with a decision–making guide and action steps. I also want to offer training to environmental engineers on the decision–making topic. My hope is to have the opportunity to participate in the implementation of the decision–making processes.

Reliability and Validity

Four logic tests form the basis from which to establish the quality of research: (a) reliability, (b) validity, (c) internal validity, and (d) external validity (Leedy & Ormrod, 2013). There is no uniform strategy for all qualitative studies (DunnGalvin et al., 2010; Leedy & Ormrod, 2013; Marshall & Rossman, 2014). Internal and external validity are not relevant to this study, as they relate to quantitative studies. Reliability refers to the

ability of future researchers to make the same observations of a phenomenon if they conduct research using the same procedures (DunnGalvin et al. 2010; Shaw, 2013). Validity refers to the extent to which the research authentically represents the phenomenon under study with precision (DunnGalvin et al. 2010; Shaw, 2013).

Reliability

Reliability refers to the credibility and repeatability of the data (Duan et al., 2014; Sokolowski, 2008). Reliability does not assure validity; however, without reliability, the possibility of validity becomes less apparent (Duan et al., 2014; Sokolowski, 2008). Qualitative research aims to minimize error and researcher bias (Leedy & Ormrod, 2013). Two main methods of reliability prevailed in this study: the application of all detailed case study protocols and the adherence to the required documentation and transcription standards (Yin, 2014). Furthermore, I incorporated several procedures to check the reliability of the instrument, the processes, and the study, including (a) more than one source of primary data (interviews and online data about the company), (b) the use of a peer review to substantiate the validity/reliability of the interview questions to answer the study's research question, (c) member checking (returning the transcriptions to the participants to verify their accuracy), and (d) use of a standardized defined case study collection and data analysis technique. Throughout the study, I reviewed notes and memos to guard against researcher bias and to increase reliability.

Validity

Validity concerns truths providing confirmation that the researcher has accurately collected the data, and guarantees that findings, interpretations, and conclusions emerging

from the research truthfully represent real–world phenomena (Frost et al., 2011). Qualitative validity involves trustworthiness, credibility, and authenticity (Leedy & Ormrod, 2013). To strengthen validity throughout the study, the study included (a) triangulation, (b) member checking, (c) disclosing and monitoring researcher bias, (d) saturation, and (e) discrepant data.

Triangulation strengthens the validity of a qualitative study (Shaw, 2013). Four types of triangulation can occur in research (Denzin, 2012). Investigator triangulation refers to the use of several researchers for one study, while theory triangulation refers the use of a different perspective to interpret the study findings. Methodological triangulation involves using different methods to investigate a problem, while data triangulation refers to the different types of sources used in one study (Denzin,; Moustakas, 1994). I used data triangulation for this study. Triangulation using multiple sources of information to form themes and patterns strengthen the validity of the study (Frels & Onwuegbuzie, 2013; Moustakas). Triangulation for this study included interviews with environmental engineers, direct observation (visits to the facilities and contact with employees), and access to internal documents. This triangulation technique provided a stronger validation of the results if they converged (Yin, 2014). Additionally, I used the participant validation technique of member checking, which is a technique used to improve the reliability, validity, accuracy, and credibility of a qualitative study (Chenail, 2012). Member checking involved asking each participant to review the transcribed record of his or her interview. I made changes as requested by the participant, and this process validated the transcribed summary (Duan et al., 2014; Sokolowski, 2008).

Reducing errors and research bias is important. Leedy and Ormrod (2013) noted that qualitative research aims to reduce error and researcher bias. I have professional experience with an engineering firm. I continued to review notes and memos to guard against researcher bias and used bracketing to remain in a neutral stance during this research (Chan, Chien, & Fung, 2013). The purpose of bracketing was to avoid the possibility that the data and the data analysis become reflections of my preconceived opinions and values (Newman & Tufford, 2012). According to Yilmaz (2013), the number of participants should be adequate to ensure saturation and to ensure that the sample includes a small pool of participants with experience in or with the phenomenon. I used the snowball method by asking the participants to assist in identifying other potential subjects to ensure that saturation occurred.

Yilmaz (2013) posited that internal validity applies to explanatory studies and not to exploratory or descriptive qualitative studies. Although internal validity does not pertain to this study because it is of a qualitative nature, tactics used to validate an explanatory study can contribute to the validity of an exploratory study (Shaw, 2013; Yilmaz). Rival thinking facilitates the process of a continual search for different or substitute explanations for a researcher's initial observations (Yilmaz). I incorporated rival thinking into the data analysis process by engaging in continuous, challenging assessments throughout all phases of the study. Before making final interpretations of the data, I continually reviewed my initial thinking during the coding and theme development phases to explore and consider acceptable rival justifications.

I addressed dependability, credibility, transferability, and confirmability as per Guba's (1981) four criteria for the trustworthiness model (see Appendix G). To address dependability, I reported the steps taken in this study in detail. Reporting the steps will allow future researchers to reproduce the work, if not necessarily to gain the same results. The detailed report (Shenton, 2004) included (a) the research design and application, describing what was intended and achieved on a strategic level, (b) the operational detail of data gathering, addressing the detail of fieldwork, and (c) philosophical assessment of the project, assessing the effectiveness of the process of review undertaken (Guba, 1981; Lincoln, 1995).

The adoption of a well–established research method ensured credibility (Guba, 1981; Shenton, 2004; Yin, 2014). I used modified interview questions from a previous Walden student's successful study. Furthermore, I did not use a pilot study; rather, my peers reviewed the interview questions to make sure that they aligned with obtaining rich answers from the participants. To ensure confirmability and credibility, I took steps to make sure that the research findings were in fact the result of the experiences and ideas of the participants, rather than my preferences. Using triangulation ensured this process. Triangulation for this study included interviews with environmental engineers and their employees, direct observation (visits to the facilities and contact with employees), and access to internal documents (in–house information bulletins, environmental declarations, annual reports for the current year), as well as external sources (press, web pages, trade registries). This triangulation technique and member checking provided a stronger validation of the results because the results converged (Yin). After the data collection

from the interviews and the online sites, I began data analysis using the NVivo analytical program. Each participant had a unique numerical code to maintain his or her confidentiality. After defining the themes, I compared and contrasted the responses of the participants. I also included an audit trail (Shenton, 2004), which will allow any observer to repeat the study step–by–step by way of the decision(s) made and the procedures described. The adoption of a well–established research method ensured credibility.

Responsibility belongs to the researcher to provide sufficient contextual information about the fieldwork site to enable transferability (Guba, 1981; Lincoln, 1995; Tsang, 2014). It is also important for the researcher to provide a sufficient description of the phenomenon under investigation that allows readers to have a proper understanding of the phenomenon, thereby enabling them to compare the instances of the phenomenon described in the research report with those that they have seen elsewhere (Shenton, 2004). I addressed the following issues in this study when gathering data by using the techniques previously stated (a) the number of participants taking part in the study and where they are located, (b) any restraints in the type of participants who contributed data, (c) the number of people involved in information gathering, (d) the data collection methods utilized, (e) the number and length of the data collection sessions, and (f) the time over which the data were gathered (Guba; Lincoln,).

Finally, validity reveals the extent to which a study's findings demonstrate analytical generalizability to other populations (Duan et al., 2014; Sokolowski, 2008). I used theoretical propositions and constant comparative analysis of the data to ensure validity (Shaw, 2013). Theoretical propositions identified in the literature review for this

study established the validity of the study's findings (Caliendo et al., 2010; Kraus, 2011). I implemented a process of constant comparative analysis by comparing data in a continuous, ongoing procedure, and by coding and recoding the data.

Transition and Summary

In Section 2, I described the purpose of the study, the role of the researcher, selection of participants, and the research method and design. Furthermore, I included a description of the population and sampling along with the data collection instrument, data collection technique, and data organization technique. Finally, I discussed the data analysis technique and the validity and reliability of the findings.

In Section 3, I will begin with a review of the purpose statement and research question. The section will also contain the results of the study, a detailed explanation of the empirical evidence, and ties to the conceptual framework as they relate to the research question and support the conclusions of the study. I will conclude Section 3 with a discussion of implications for social change, researcher recommendations, and reflections.

Section 3: Application to Professional Practice and Implications for Change

Introduction

The purpose of this qualitative, exploratory case study was to find effective decision–making strategies that help environmental engineers acquire profitable environmental redevelopment projects. The specific business problem was to address environmental engineers' lack of effective decision–making strategies to support the acquisition of profitable environmental redevelopment projects. This section includes a detailed review of the data collected, the findings from the case study design, and an overview of the study. I present findings related to the research questions discovered via data collection, documentation review (internal documents such as in–house information bulletins, environmental declarations, and annual reports for the current year, as well as external sources such as press releases, web pages, trade registries), and the study interviews. Five themes and patterns were identified that include the need for a go/no–go company assessment (see Appendix I), coinciding with a MCDM method (see Appendix A), which is used if a project decision is to move forward. Finally, I discuss the manner in which the findings are relevant to professional practice, the implications of the study for social change, recommendations for future research, and reflections.

Presentation of the Findings

During the data collection phase of this research, MCDM methodology served as a backdrop for investigating profitable decision–making tools for environmental engineers (Charnes et al., 1955; Contini & Ziont, 1968; Kaklaukas et al., 2010; Wallenius & Ziont, 1976). As noted earlier, I gathered data using three techniques: internal and

external documentation review, interviews, and direct observation. Using the document review process, I included in this study the company's assessment tool, the go/no–go matrix (see Appendix I). This matrix is one of the important pieces of information in profitable decision making for the organization.

Direct observation of the company's office showed that the organization takes pride in acting ethically as visual posters and the actual company's code of ethics was in plain view on the walls of the conference room. External documents retrieved from searching the web and trade associations included articles and press releases about the organization's projects, awards, acquisition of other environmental companies, and financial standing, which substantiated the fact that the company was a leader in the field of environmental engineering.

Of all of the data techniques used in data collection, including documentation review and the one–on–one interviews, the largest quantity of data came from the one–on–one interviews. All participants in this study were employees of an engineering firm located in Camden County, New Jersey at the time of the study. The sample of participants included one principle owner, a chief financial officer, and two project managers. Following the face–to–face interviews, I used NVivo to code the data collected and to remove personal identifiers. To protect the identities of the participants, I did not incorporate identifiers into the findings relating to the individual responses to the interview questions included in the final report. I identified them as P1–P4 (Participant 1–Participant 4) in the order that the interviews occurred. I then grouped all data into themes, which provided the information necessary to create guidelines for environmental

engineers. As suggested by Elo et al. (2014), I collected, analyzed, and grouped the data into themes as presented in Appendix G. These data highlight why the study site was able to generate profits in the environmental division of the company, which is one of the most profitable divisions in the company.

In the following subsection, I outline the five themes and three subthemes derived from the analysis done in NVivo. The themes for profitable decision making that emerged from this study were the MCDM assessment process, with a subtheme of GR; a go/no–go assessment process selection; education and training, with a subtheme of mentoring; ethics as an organizational value; and good project management, with a subtheme of using incentives for employee motivation. This section concludes with a review of the patterns found in response to each research question.

Theme 1: MCDM Assessment Process

The project managers at the organization under study used the MCDM tool that I discussed extensively in the literature review as part of the assessment for profitable decision making. In the literature review, I encompassed the different MCDM tools and discussed MCDM within the conceptual framework of this study. Researchers have provided evidence that MCDM is a theory used in environmental decision making (Charnes et al., 1955; Contini & Ziont, 1968; Kaklaukas et al., 2010; Wllenius & Ziont, 1976). MCDM includes goal–directed behavior in the presence of options and uncertainty (Durbach & Stewart, 2012). I showed the participants the application of decision support tools for environmental management (see Appendix A), and P1, P2, and P3 noted that these tools and assessment are part of the decision–making process. Depending on the

project, MCDM assessments can determine the best profitable scenario to use in a project (Vecchiato, 2012). The analysis of this theme brought forth information regarding remediation cleanup and which MCDM tool the project manager will use to complete the project. When analyzing the data, information became evident that can help determine the remediation standard, such as what the client's end use is and whether the client wants the site completely clean, as compared to wanting a cleanup where they can manage with the contamination in place. As stated in the literature review (Agarski, Borut, Hodolic, & Kosec, 2012) and brought out in the interview process, the MCDM tools help the organization determine how to move forward with the remediation. End use is a significant factor in which MCDM method the project manager will choose to use.

Another factor, which may cause corporations not to use a certain MCDM, is the cost (Agarski, Borut, Hodolic, & Kosec, 2012). The client has to be involved in the decision process because of cost and take on some of the risks of choosing the best method to use. P2 discussed cost factors in the interview process and described some of the factors of cost that would include, "does the client want a permanent or temporary cleanup. There is a risk in both, and the project manager factors the risk into the evaluation of the remedial method." P3 offered more suggestions about what kind of remediation would come from the MCDM assessment, such as "is the method of remediation implementable, technically defensible, does the method protect human health and the environment, and finally does the method meet the end users' needs for the ultimate use of the property". Methods of remediation vary according to the needs of the client and/or scope of the project (Bjerg, Lemming, Hauschild, & Owsianiak, 2013). The

MCDM assessment helps to understand the method most appropriate for the project (Agarski, Borut, Hodolic, & Kosec, 2012), which then allows the company to determine whether the firm should move forward with the project or not. P1, P2, and P3 stated MCDM is an important part of profitable decision making. In general, P1, P2, and P3 stated that the methods coincided with whatever the regulations require. P2 summed it up best by stating, "Choosing the MCDM method is determined by balancing the client's goals for end use and the cost of dealing with the contamination."

Subtheme: Green Remediation (GR)

In alignment with the social impact of this study, a subtheme of the MCDM assessment process emerged. I discussed this subtheme, green remediation, in the literature review and the participants discussed how project managers incorporate green remediation in their one–on–one interviews with me. GR is an MCDM approach (Govindan, Murugesan, Rajendran, & Sarkis, 2013). GR aligns with the research question and business problem because research has shown that GR may or may not be the most profitable way to approach a project (Hashemi, Karimi, & Tavana, 2015). The participants in this study brought understanding to how they incorporate profitable sustainability approaches to project selection. When determining whether to use green remediation in a project P3 stated:

> Project managers try to incorporate green remediation strategies into their thinking and their proposal offerings to their clients. Our green remediation strategy would have to be successful and the project manager bases using green remediation on economics, and on wanting not to worsen the environment.

P2 gave an example of a current project where the contamination of concern was chlorinated hydrocarbons in the groundwater, and the project manager elected to treat it naturally by injecting food waste that is like lactate, a milk by–product. P2 stated:

> Treating the contamination this way helps force the natural degradation of that material instead of injecting a synthetic material into the environment that may or may not break down over time. By using this method, the organization balances the success or failure of that with the cost and the long–term benefits of green approaches.

P1 noted that GR is sometimes client driven. Sometimes clients choose green solutions and sometimes they do not, based on their needs such as cost. A client may have choices that include building on, cleaning up, or keep using the property as is. P1 gave an example stating:

> If the business is a manufacturing company and the company had a contaminant release, and it is an accidental release the client ultimately wants to get back in compliance, and the client wants to continue to run their business. The cost would be an issue. It would be the project manager's job to factor that cost into the redevelopment and determine if green remediation is the best for this project.

As in regular remediation, methods vary in green remediation and the choice to use green remediation would depend on the regulatory requirements that are different in every state or city (Eckerd & Heidelberg, 2015). Different states and various agencies have different requirements and the method chosen would change based on what the requirements are. P1 stated:

> The bottom line in using green remediation depends on cost that is profitable to the organization and the client. The organization would have a hard time staying in business as an environmental consultant if they only worked on projects where the organization could create a sustainable resolve. Oftentimes, the plan for the organization is to get in, assess the contamination, clean it up or stabilize it; but wherever the project team can incorporate types of sustainable concepts, the company would always like to do that and the organization has project managers that are trained to lead projects that can do just that.

As noted in internal documents, employees with this background are mostly in the organization's civil engineering department. The environmental staff can reference and speak to them and incorporate different things like rain gardens and different types of concepts related to site drainage and ground storm water retention, where the organization can incorporate sustainable concepts that meet the site constraints, needs, and the environmental impact as well. It is evident that green remediation is something that the study site strives to do. There could be additional cost benefits, but the organization is sensitive to the client's needs and budgets. Table 1 shows a summary of Theme 1 (see Appendix J).

Theme 2: A Go/No–Go Assessment Process Selection

While there is frequent use of go/no–go assessments in the health field (Jernigan et al., 2015), project managers at this study site also used a go/no–go assessment as part of the decision–making process (see Appendix I). Determination to move forward on a project starts with a set of criteria based on an assessment of likely potential scenarios.

The values assigned to criteria include the historical performance of similar projects which pose potential significant risk or strengths of the project assessed. The go/no–go process is the main decision–making factor, and I provided a copy of the participation site go/no–go matrix (see Appendix I). Using this assessment as a decision–making strategy substantiates good decision making and aligns with the research question and business problem because this assessment tool can factor in possibilities of a project being a success (profitable) or a failure (nonprofitable).

As noted on the go/no–go matrix (see Appendix I), three people who are familiar with the proposal opportunity should complete the go/no–go matrix. For each proposal factor, participants in making the decision should record an estimated rating from 1 to 6 based on the decision criteria provided. The participants can choose to do the same for a prominent competitor or two. The overall rating should be at least 4.0 before deciding to submit a proposal. A 4.0 rating would mean that experience is part of the deciding factor to move forward with the project. If the overall score is less than 4.0, an office director's and or regional vice president's approval is required before proceeding with the proposal.

All participants in this study, except one, were involved in filling out the go/no–go matrix. This person worked in the financial department of the organization. The finance department is instrumental to company profitability. P4 stated, "I am not involved in the go/no–go process, but I am involved in the financial part of the decision making after the go/no–go process is completed and the decision is to move forward with the project."

In general, P1, P2, and P3 like using the go/no–go matrix as part of the process. P1 said it best, "It is an important tool needed in the process because most times it will capture the identifiers of a project that are necessary to determine if the project should be taken on." The analysis of the go/no–go process shows that the matrix incorporates communication that helps the organization prepare proposals. P3 stated:

> Once the group level makes the decision to move or not move forward based on the go/no–go score an officer agrees or disagrees with the decision. If the officer decides to move forward with the project, then the organization starts to look for the best team to take on the project and determine how to go about the project using an MCDM tool.

The go/no–go assessment tool is significant in the determination process to establish whether to move forward or not on a project. P1said, "Using the go/no–go assessment tool offers documented information that can be reviewed by upper management especially when the decision is to not move forward with a project. Upper management can review the matrix and the decisions made." Saturation was met within this theme as patterns (see Appendix G) emerged. Table 2 shows a summary of Theme 2 (see Appendix K).

Theme 3: Education and Training

Environmental education must keep up with how the world changes in order to be effective (King, 2012). During the interview process, a strategy for education and training emerged. A need for education, training, and mentorship relates to the research question of this study because management training, education, and mentorship are constantly

seen as an efficient manner of providing organizations with the management expertise they require to make profitable decisions (King). The specific business problem for this study was that some environmental engineers lack effective decision–making strategies to facilitate the acquisition of profitable environmental redevelopment projects. The participants of this study proved that the improvement of decisions could happen because of education, training, and mentorship. Overall, P1, P2, P3, and P4 noted that education, training, and mentoring give the participants a better insight into project management and can contribute to profitable acquisitions of redevelopment projects. P1 said it best, "Decision–making education and training can empower environmental engineers and prepare them to deal with difficulty, uncertainty, diversity, and change."

All participants noted that their education and training was necessary because it enhanced their decision–making skills. Participants P1–P4 showed me diplomas and certifications of various degrees and training. P3 joined a startup environmental consulting firm right out of school. The participant discussed participation in the creation of that company and the growth of that business. P3 discussed how the company grew from eight employees at the start of the company creation to 100 employees a few years later. P3 stated;

> Being able to get into a startup company and be one of the people within the company that established procedures, which included writing field manuals and doing training of other employees, gave me a good basis for how to run a profitable business in the environmental industry.

All participants mentioned in the interview process that the participation site's management trains employees on a regular annual basis. The management of the firm also offers to train other companies and environmental engineers as well. I reviewed the training manual. The documents that stood out most to me were those that were used to train on MCDM as found in the literature review. P3, who conducts training, noted that the organization gets involved in training because "it gives one a real basis for doing things right, knowing the correct procedures and requirements." P2 stated, "Administering the training gives project managers a sound basis for profitable decision making and helps in project management growth."

When looking at the internal training manual I noticed there are different tracks of training at the participation site. Track 1 would consist of a lower level project management course offering the basics of managing a project. Track 2 training includes technical training for those project managers who are not inclined to want to head a project, such as understanding MCDM assessments. Track 2 would be for those engineers who are more adept at working at their desks on issues that are more technical, writing reports and sampling problems. Track 3 is more intense where project managers train on working with clients and other stakeholders and get an understanding of the go/no–go process. The training supports the different levels of employees to help them advance through the company.

Subtheme: Mentoring

During the interview process, a strategy for mentoring materialized. Mentoring is beneficial in professional growth for engineering disciplines, principles, skillfulness, and

knowledge–based learning (Mason, Santora, & Sheahan, 2013). Mentoring is a characteristic of specialized learning and occupation training in which a more high–ranking and knowledgeable person (the mentor) and a more novice person (the mentee) join in a relationship in which the mentor directs the mentee so as to augment career success (National Academy of Sciences, 1997). In general, P1, P2, P3, and P4 noted mentoring as a positive influence in their decision making because the participants could learn effective project management skills. Learning effective management skills aligns with the research question and the business problem.

Overall, mentors for the participants in this case study have been managers and colleagues within the firm and outside the firm. P1, P2, P3, and P4 stated that mentors have offered examples of successes and failures in decision making. P2 stated, "Mentor training has also led to improved understanding of the values in the workplace and the profession, including learning appropriate professional behaviors." P3 said it best, "working with a mentor helped me in evaluating situations and opportunities such as the opportunity to pursue or not pursue a project." When evaluating the data, I discovered that learning from mentors over time allowed engineers in the case study to use their skills and assets, and then incorporate that into decision making. Saturation was met within this theme as there was enough information to replicate the study and no new information emerged, and therefore no further coding was feasible. I present a summary of Theme 3 in Appendix L.

Theme 4: Ethics as Organizational Value

Participants in this study noted that when responding to uncertainties and complexities in environmental projects, the direction must come from project managers and department heads. As stated in the literature review, Eckerd and Heidelberg (2015) identified many tools to choose from when doing remediation and that knowing the best tool or strategy is important because environmental issues often encompass ethical and moral values not associated with any economic use or value. Making important decisions in the absence of sufficient information and tools not only hinders one's performance and ability to maintain ethical and moral values, but also often hurts other stakeholders (Fast et al., 2012). Using the strategy of ethics in project management supports the research question and business problem. Kiel (2015) reported that ethical leadership affects the bottom line. The researcher found that chief executive officers whose employees gave them high marks for character had an average return on assets of 9.35% over a 2–year period; this statistic is nearly five times higher than for those with low character ratings who had a return on assets of 1.93% (Kiel). The interviewed participants provided information that ethics leads to a host of positive outcomes in project management, and reduces the risk of many negative outcomes.

When I asked the participants the question about attributes needed in successful decision making, they all talked about ethical decision making. P2 described it best by stating, "I have an obligation to the organization to make a profit for the organization, obey the law, and to be ethical in dealings within the project and with all stakeholders". Acting ethical on project management does not have to be a complex issue (Kiel, 2015).

P1 noted, “in project management the organization’s management is trying to pursue business that fits with the organization’s goals, objectives, and business plan.” This strategy is one of the organization’s business models and coincides with the organization’s core tenet of being ethical in all dealings, also noted on the website and on wall plaques in the office. The company sets high ethical standards by pursuing opportunities that are good for the community. P3 discussed situations when the project team is dealing with problems such as contaminated sites and gave an example of the organization trying to solve the problem. P3 said, “The project manager will use one of the MCDM tools that is best for the community; the project manager works to get the client on board even if it costs more to do the project.”

Integrity is part of the organization’s mission as noted in company documents. A statement about integrity is on the organization’s website and in trade magazines referring to the organization as promoting honesty. P2 gave an example of bidding on a proposal when many factors come into play, such as “how competitive the bid is, what kind of budget the prospective client has, and what kind of flexibility with scheduling and budgeting the organization has.” Those sorts of factors would enable the project manager to make creative decisions on how the organization could approach the scope. P4 stated,

> If it were a limited budget, within a competitive bid, with a simple project, with a defined scope, the organization would try to base the proposal on cost. But if it is just a general problem, where the project involves a questionable site, the project manager could inflate the cost of the project and charge more for the project by working within the prescribed scope the prospective client has put together.

However, management of the participation site does not operate that way. P1 said,

> The organization's project managers would create another proposal that can get the project done less expensive taking into account all stakeholders. The project managers like doing proposals this way because it allows the organization to display their creativity and problem–solving skills by showing the business a better way of doing the project that may be cheaper and not just doing something, as prescribed.

Saturation was met within this theme as there was enough information to replicate the study and no new information emerged, and therefore no further coding was feasible. I present a summary of Theme 4 in Appendix M.

Theme 5: Good Project Management

Harrington, Nixon, and Parker (2012) conducted a review of the literature on the need for project management, revealing how project managers are an essential factor, influencing either the success or failure of a project. This research (Harrington, Nixon, & Parker) agreed with the responses from the participants in this study, as well as information found on internal documents, which included an organizational chart. Some project managers are division managers. I noted in internal documents that the division managers are the responsible party between management and client, and between management and staff. Division managers report to upper management and are the focal point in the organization, and top management supports them in their abilities to do what they need to do to satisfy clients and maintain contented staff.

I also noticed in reviewing internal documents that, depending on the scale and the specifics of the project, the project manager takes the leading role and decides just how to do the project with the help of the assessment tools in place, sometimes without consulting anyone. P1 stated, "Project managers have to deal with the uncertainness of the project and be sure of their decision without hesitation or ambiguity." P2 said, "There is only one project manager on smaller projects but typically, for a larger project, like five or six dollar figure projects, there would be a combination of a project manager, a division manager, and then a vice president." The organization's management emphasizes the decision to commit resources of the company, and thus to pursue a project; most times there is a person at the officer level or above in the decision making. P4 stated, "Profitable decision making requires committed managers to acclimate business strategies and undertakings to meet the needs of the organization and its stakeholders." All stakeholders have valuable roles to play in the overall process (Manetti & Toccafondi, 2012). Project managers can identify an opportunity of a project, but the decision to pursue the project and be involved in the price, a project team must complete a go/no–go matrix.

Subtheme: Using Incentives for Employee Motivation

Rewarding and measuring employees' performance for good project management is a good decision–making strategy that can affect the bottom line as well, and thus aligns with the research question for this study. Gupta and Shaw (2014) suggested that incentives could shape employee and organizational effectiveness. Using incentives to motivate employees emerged as a subtheme of a need for project management. P4 said,

"Doing the evaluation of the project and in decision making, it is important to offer incentives to motivate those that are included in the project to do their best. Incentives helped employees be highly productive." I noticed in reviewing internal documents that the organization offers rewards for profitable decision making, which include a bonus program. The organization offers spot bonuses on projects when people work on complicated projects and can get the projects done and deliver them profitably. The organization gives bonus rewards for meeting or exceeding project goals, and this type of incentive has done well for the organization. The organization has rewarded those members of the team, and that is a method used to encourage profitable decision making. P2 said, "The rewards may be dinner for their family, tickets to a ball game, minor things, but the incentives are thoughtful ways to acknowledge that somebody has put in the effort to do their best." I also noticed when looking at internal documents that project managers have the bonus program built into their goals and agenda. For instance, project managers are required to secure a certain amount of business and manage that business at a certain profit margin or multiplier. Employees know the vision, and that profit is part of the mission of the company. Project managers get rewards, such as bonus and raises and possibly promotions when making profitable decisions.

Finally, I noticed in internal documents that the organization has been able to keep talented employees and grow the business from 40 employees to close to 100 employees at the participation site location, partly because of employee incentives. The organization has had very few layoffs for lack of work. There was a lack of work during the recession, but the organization was able to bring back everyone laid off. P1 stated;

> Being able to keep trained personnel is part of our profitable business strategy. There are tough decisions that have to be made to maintain a successful company, but overall all one of the organization's business models is to, get the work, do the work, and be paid for the work.

Saturation occurred within this theme as there was enough information to replicate the study and no new information emerged, and therefore no further coding was feasible. I present a summary of Theme 5 in Appendix N.

Summary of Themes

The themes described in this section establish criteria for addressing profitable decision–making concerns and issues within environmental engineering. The first theme identified in this case study centered on the literature review and the MCDM tools, and served as the conceptual framework for this study. This framework provided the perspective for the case study, allowing me to address environmental, social, and economic factors, while maintaining a focus on the need to understand causes, effects, and underlying interactions for profitable decision making in environmental engineering. The data analysis undertaken from the collected data detailed a need to address not only the integration of MCDM applications, but also a predetermination of go/no–go processes using a matrix focused on proposal factors and criteria (see Appendix I). In the MCDM assessment (see Appendix A) mentioned in this study, I focused on the MCDA required to complete the projects, and the resultant solutions included additionally a go/no–go process (see Appendix I).

GR is an MCDM method used in environmental projects. When it comes to the actual remediation method used on a project, the MCDM process is important whether the firms decide to use GR or not. GR is a consideration, but it is not one of the initial decisions or at the forefront of every decision–making process. The organization is sensitive to the client's needs and budgets, and MCDM helps project managers determine whether it is beneficial to use sustainable approaches in projects.

The second theme was a need for a go/no–go assessment. Politics, conflicts of interest, responsible parties (whether one or multiple), and community all play a role in the decision–making process and the go/no–go assessment can be a tool to help management flush out these issues before accepting the project. The go/no–go process is the main decision–making factor, and I provided a copy of the participation site's go/no–go matrix (see Appendix I). Using this assessment as a decision–making strategy substantiates good decision making and aligns with the research question and business problem because this assessment tool can factor in possibilities of a project being a success (profitable) or a failure (nonprofitable).

The third theme included a need for education and training, and a subtheme of mentoring. Education and training that contributed to decision making started early with a college education and continued with certifications, training, and continuing education after college. Participants noted that their studies and/or training play a vital role in their decision making. Participants agreed that their education and training helped them to know how to write procedures and initiatives for their projects. Decision–making

education and training can empower environmental engineers and prepare them to deal with difficulty, uncertainty, diversity, and change.

Participants in the study noted mentoring as a positive influence in their decision making. Having the support of someone who has previous experience in project management decision making was vital to the participants. Mentors varied for each participant. Mentors ranged from people who participants worked with at previous engineering firms to educators and colleagues at the participation site. The skills and knowledge that the participants stated having acquired increased the participants' level of support needed to take on project management. Participants noted that company management implemented additional mentoring because of bad decisions, or non–profitable decisions on projects. Participants also learned how to evaluate opportunity from past failures, as well as their colleagues and mentors past failures and successes.

The fourth theme was ethics as an organizational value. As stated in the literature review, Eckerd and Heidelberg (2015) identified many tools to choose from when doing remediation and maintained that knowing the best tool or strategy is important because environmental issues often encompass ethical and moral values that are not associated with any economic use or value. Making important decisions in the absence of sufficient information and tools not only hinders one's performance and ability to maintain ethical and moral values, but also often hurts other stakeholders (Fast et al., 2012). Participants in this study cared about ethical practices and decision making, and the organization reflects ethical standards in the conference area where the interviews took place, on website searches, and in trade magazines. Ethical decisions for environmental engineers

included remediating problem areas correctly and selecting the best method for the project and the organization.

The fifth theme was good project management. The participants stated that no particular management standard is appropriate throughout the project. Depending on the scale and the specifics of the project, the project manager takes the leading role and decides just how to do the project with the help of the assessment tools in place, sometimes without consulting anyone. Project management performance, therefore, must be flexible to support the phases of the project. The participants in the study noted that profitable decision making requires committed managers to acclimate business strategies and undertakings to meet the needs of the organization and its stakeholders. All stakeholders have valuable roles to play in the overall process (Manetti & Toccafondi, 2012).

A subtheme of using incentives to motivate employees derived from the theme of project management. The company management feels that it is important to motivate employees by offering incentives. This stimulates employees to stay with the organization and helps the organization keep their trained employees. Overall, the organization's model as one participant stated is to "allow employees to get the work, do the work, and be paid for the work". Saturation was met within this theme as patterns were formed that showed all participants had their views on profitable decision making, and their opinions are what helps the organization as a whole with decision making. The data gathered in this study brought forth themes that revealed the information required for

the environmental engineering firm's project managers to focus on profitable decision making. Figures 1, 2, and 3 illustrate the resultant solutions.

Applications to Professional Practice

In this study, I focused on strategies that help environmental engineers make sound decisions to acquire profitable environmental redevelopment projects. The GAO estimated that 450,000 brownfield sites exist nationwide (Eckerd & Heidelberg, 2015). The findings of this case study may facilitate opportunities for environmental engineering firms to move toward successfully to take on more of these projects by not only implementing MCDM, but also go/no–go assessments into their daily business practice. A knowledge gap related to the go/no–go decision–making assessment in environmental engineering was evident in the data analysis and I addressed it in this study. In this research, I explored the steps necessary to implement a go/no–go assessment in an engineering firm, addressing the procedures and methods of go/no–go assessment and MCDM from project inception through launch. Because I examined one company within one industry, the results may not be valid for all environmental engineering firms. Specifically, I addressed the application of steps to a single organization.

Application of this case study to other engineering firms could reveal opportunities for other companies to integrate go/no–go analysis and MCDM assessments into day–to–day business practice. The implications of this study may affect project managers and the quality or environmental projects within engineering firms. Specifically, the findings of this study can change the manner in which environmental engineers take on projects, with a new emphasis on company–initiated go/no–go

assessments and including MCDM assessments. Further implications could reveal the need for more go/no–go peer–reviewed research on the collaboration of both evaluations.

Implications for Social Change

As noted earlier, environmental pollution is another challenge faced by building companies that focus on GR (Zhang, 2013). Construction companies endeavor to solve these issues to improve the environmental sustainability of green building projects by using different building methods (Al–Tabbaa & Hou, 2014). The selection of the methods for building projects involves a multi–faceted decision–making process (Chang, Hsu, Lee, Lin, & Tsai, 2013). The purpose of this qualitative case study was to find strategies that help environmental engineers make good decisions to acquire profitable environmental redevelopment projects. Organizations around the world are increasingly taking into account environmental and social demands as they endeavor to realize success beyond financial returns (Fairfield & Harmon, 2014). Various agencies, remediation engineers and other stakeholders (Zhang) are increasingly recognizing green remediation (Hashemi, Karimi, & Tavana, 2015; Lubrecht, 2012). I presented the findings of this study to promote social change by highlighting the gap between current practice and greener options. Lee, Peng, Wang, and Wu (2013) stated that neighborhood sustainable growth should not be the main focus in demolition and construction projects, but project managers should also focus on local values and revitalization. This research may serve as a foundation for educating leaders of environmental firms and other community members about the usefulness of including the green methods in their decision making. The

findings could positively affect leaders of environmental firms desiring to integrate green methods into future project redevelopment.

The social effects of this research include its contribution to the environmental engineering business scenario via a real–world case study that provides a resource for leaders desiring to incorporate a green practice into their organizations. The initial intent of the study was to examine the steps necessary to make profitable decision making about environmental redevelopment projects. During the preliminary analysis of the data, several themes emerged, one of which I did not anticipate (i.e., a pre–analysis of using a go/no–go assessment). By establishing a go/no–go assessment, these organizations can work together to set precise goals and objectives for GR as well as non green remediation.

Application of the findings of the study to other environmental engineering firms could pose opportunities for other companies to integrate GR methods into day–to–day business practice. Considerations include compensating employees who implement the practice, and working with vendors and suppliers that support a green practice. This research has added to the growing body of knowledge in the United States on sustainable remediation and related opportunities for environmental engineering. I documented the benefits of GR for the study site, and the results section includes a focus on the proactive management of environmental decision–making issues as it relates to green remediation.

Understanding methods such as GR for environmental engineering is essential for sustainable decision–making research. Such activities reduce the environmental effects and are hence good for business (Al–Tabbaa & Hou, 2014). Defining the input, output,

and processes reviewed by decision making illustrates sound business practice that can serve as a baseline for other environmental engineers seeking methods toward the reduction of adverse environmental effects. Scholars must understand processes toward greening because the aggregate effects of GR are significant (Al–Tabbaa & Hou, 2014). All of the points mentioned above support the need for leaders in environmental engineering to understand the environmental effects of their business practice and the drivers toward green operation.

Recommendations for Action

Decisions are choices made from available alternatives (Clemen & Reilly, 2013). Decision making is the process of identifying problems and opportunities, and resolving them in one way or another (Clemen & Reilly, 2013). Decision making happens amid ever–changing factors and unclear information that may have conflicting points of view. As taken from the themes and patterns noted in the data analysis, techniques for improving decision making in organizations are important to profitability. Successful decision making includes the establishment of clear boundaries and resources determining the input and output during a process, and identifying the process that results in the best possible decision. My recommendations for actions are to take the steps as

explained in this study in Themes 1 through 5 as summarized in the diagrams below:

Figure 1. Guideline to successful decision making that can lead to profitability

I used circular Figure 1 above to show that all five themes are necessary for profitable decisions in the environmental engineering company that I studied. The themes and patterns identified in data collection provided evidence of this process are reproducible in the environmental industry. Figure 1 shows a course of action that includes a set of values in the assessments that consider uncertainties in the decision making procedure. Furthermore, understanding the connection between the above assessments and practices is important for future research on profitable decision making in redevelopment projects. Researchers must continue to examine best practice to close the gap between theory and action.

Figure 2. Process for successful project implementation as described in themes one and two and the literature review

Profitable decisions can happen in unique and poorly defined, unstructured situations when project managers follow the six steps illustrated in Figure 2. Cases occur often enough to enable decision guidelines to be developed. Using the guidelines in these themes can help in project management when certainty and uncertainty are involved, for example, when difficult decisions need to happen amid changing factors, when information is unclear, and when a project manager has to deal with conflicting points of views.

Decision–making education and training can empower environmental engineers and prepare them to deal with difficulty, uncertainty, diversity, and change as noted in Theme 3. Making important decisions in the absence of sufficient information and tools not only hinders one's performance and ability to maintain ethical and moral values, but

also often hurts other stakeholders (Fast et al., 2012), as noted in Theme 4. I noted in Theme 5 that project managers deal with the uncertainness of a project and need to be sure of their decision without hesitation or ambiguity. Additionally, profitable project management in the midst of certainty, validity, uncertainty risk, and ambiguity is possible as stated in the literature review (Durbach & Stewart, 2012; Hipel, Kilgour, & Kuang, 2015; Vecchiato, 2012). As taken from the literature review (Durbach & Stewart, 2012) and Themes 3, 4, and 5, some conditions affect possible decision failures as shown in the diagram below:

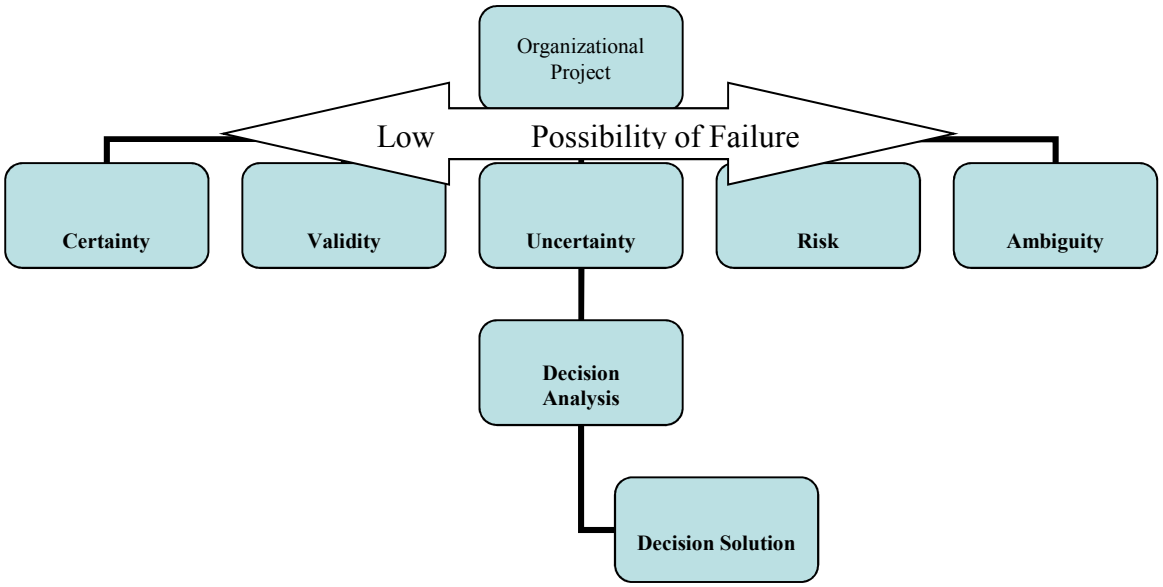

Figure 3. Conditions that affect the possibility of decision failure as described in themes 3, 4, and 5, and the literature review

My recommendation is that environmental engineer project managers, as well as everyone involved in the decision making of project selection, use the guidelines in this study, also summarized in Figures 1, 2, and 3 to make logical decisions in the organization's best economic interest. The decision maker should operate to accomplish

known and agreed upon goals identified when decision makers have education, training, and organizational values such as ethics, and good processes such as the go/no–go matrix and the MCDM assessment tools. Decision makers should strive for conditions of certainty, but they can positively make good decisions in uncertainty by gathering comprehensive information when possible. The decision maker should use a go/no–go assessment (see Appendix I) to determine whether the project is feasible to take on and then use MCDM (see Appendix A) to evaluate alternatives. Dissemination of the results of this study could happen at environmental engineer conferences, in environmental training, as well as in future literature as discussed in the next section for recommendations for further research.

Recommendations for Further Research

Scholars have tried to formulate a tool that combines criteria to come up with a better way to make environmental decisions (Eckerd & Heidelberg, 2015), but a gap in the research exists. The gap in the research relates to the existing decision approaches that offer little direction on how to evaluate the relative significance of information from each resource (Agarski et al., 2012). Banaitienė et al. (2015) noted that a mixed methods approach that can help in project selection could be on the horizon. Further research can offer inquiry into the integration of a go/no–go assessment with MCDM into decision making by the environmental engineering industry. After doing a peer–reviewed search on applying the go/no–go assessment in environmental decision making, I found a limited amount of literature to review. As stated above, researchers must continue to examine best practice to close the gap between theory and action. This study provided an

opportunity for additional research on profitable environmental decision making. The focus was on the environmental engineering industry. One may gain additional insight by not limiting the study to one engineering firm.

Additional research can offer an examination of sustainability priorities in decision making for the environmental engineering industry. For example, within the study and current research, it was evident that environmental engineers must rely on multiple factors to make profitable decisions on project selections. Specifically, the need emerged for mentorship, education and training, ethics, assessment tools, partners, opportunities, and incentives. Future research could investigate the current practice of more engineering firms within the industry. The implementation of more research on MCDM assessment tools and the use of go/no–go assessments need to take place. Jusoh, Khalifah, Mardani, Nor, and Zavadskas (2015) conducted a study that reviewed 79 articles from 51 journals on MCDM assessment tools published from 2001 to 2015. The researchers determined that the published work on MCDM in 2011 was more than any MCDM published work in any other year. There were even fewer articles on the go/no–go assessment tool for environmental engineers. The lack of literature indicates an opportunity for increasing not only the research on assessment tools for environmental engineering firms, but bringing an understanding of the interactions between decision making and various social, economic, technical, and environmental processes related to profitable decision making.

Reflections

As noted earlier, my background and expertise in this study derives from working with environmental engineers on request for proposal projects while working at a governmental entity. My areas of expertise are in decision making but lie outside the realm of how environmental engineering firms make the decisions on how to take on profitable projects. To prepare for the study, I dedicated over 4 years to researching over 400 articles found using Google Scholar searches and the Walden University Library database relating to concepts about decision making to develop the needed knowledge in current trends and opportunities for environmental engineers. My interpretation of the data, which could be perceived as subjective, was required. The findings in this study did not change any perception(s) that I had with regard to environmental decision making; however, the research provided me with a clearer understanding of the processes involved, such as how profitable decisions are made and how more opportunities can be created through a collaboration of assessments. Some of the perceptions that I had prior to my research were that environmental engineers use assessment tools in decision making, specifically the MCDM tools mentioned in the literature review. Using the MCDM tools mentioned in this study offers clear and concise ways to get through an environmental project, taking away some of the risk and uncertainty. Conducting the literature review allowed me to know how to determine what tool to use in a given situation. My perception of project management and how it is important to profitable decision making was confirmed in this study as well. From working on several projects with engineers, I understand the importance of project managers and the expertise they

bring to a project team. I also understand the importance of using the strategy of ethics as an organizational value. However, the strategy that was unanticipated in the research was how environmental engineers determine whether it is feasible to take on a project using a go/no–go matrix. The normal use of a go/no–go assessment is in the health industry, where healthcare providers use go/no–go assessments to determine whether they should move forward with the care of a patient. Furthermore, using the strategy of partnerships, mentorships, education, and training to make profitable decisions was unexpected.

Conclusion

Environmental engineers must make decisions as to which projects are salvageable (Eckerd & Heidelberg, 2015), because leaders of such organizations have an obligation to know how to make profitable decisions that extend beyond the organization financially, and what is best for all stakeholders. Additional research to investigate profitable decision making in environmental engineering firms may be useful for leaders when responding positively to projects that include the use of green practices whenever possible. I applied the MCDM theory in this case study to create a systematic approach to exploring profitable decision making tools within an environmental engineering firm in Camden County, New Jersey. Theoretical tools help organizations to create opportunities for profitable decision–making operations. The business case for profitable decision making is that this practice benefits all stakeholders and creates a corporate culture wherein all participants take on investment into the project. Given the correct assessment tools, all companies can institute a profitable decision–making process toward environmental redevelopment. Significant potential exists in action toward green

remediation practice as well. Leaders of environmental engineering firms must review their business practice, policies, education and training, and assessment tools to create a program that addresses gaps between objectives and linked goals. Continued research in the field may result in a clear link between theory and the practical application of profitable decision making on project selection.

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Appendix A: Application of Decision Support Tools of Environmental Management

Application area	Method	Decision context	Funding Agency	Citation
Prioritization of sites/areas for industrial/military activity	AHP + GIS	Land condition assessment for allocation of military training areas	U.S. Army of Engineering and Research and Development Center	Mendoza et al. (2002)
	AHP + GIS	Selection of boundaries for national park	International Institute for Geo information Science and Earth Observation, The Netherlands	Sharifi et al. (2002)
	PROMETHEE	Waste management activities in Canada	Natural Sciences and Engineering Research Council of Canada	Vaillancourt & Waaub (2002)
	ELECTRE + GIS	Land management to develop a land suitability map for housing in Switzerland	Swiss National Foundation for Research (FNRS)	Joerin & Musy (2000)
	AHP + GIS	Landfill sitting		Siddiqui et al. (1996)
	MAUT + GIS	Selection of park boundaries	USDOE	Keisler & Sundell (1997)
Environmental/remedial technology selection	SMART	Choosing a remedial action alternative at	US Army Corps of Engineers	Wakeman (2003)

Application area	Method	Decision context	Funding Agency	Citation
		Superfund site		
	MAUT	Selection of management alterations	University of Missouri – Columbia, USA	Prato (2003)
	MAUT + AHP	Regulation of water flow in a lake–river system	Academy of Finland	Hamalainen et al. (2001)
	MAUT	Offsite emergency management following a nuclear accident (such as the Chernobyl accident)	European Commission Ukraine	Ehrhardt & Shershakov (1996); Hamalainen et al. (2000)
				(table continues)
Environmental impact assessment	Review	Review of MCDA use for EIAs in Netherlands	Vrije University, The Netherlands	Janssen (2001)
	AHP	Socioeconomic impact assessment for a construction project in India	Indira Gandhi Institute of Development Research, India	Ramanathan (2001)
	ELECTRE	Highway environmental appraisal in Ireland	Dublin Institute of Technology; University College Dublin, Ireland	Rogers & Bruen (1998)
	AHP and MAUT/SMART	Environmental impact assessment of two water	Finnish Environmental Agency; Helsinki	Marttunen & Hamalainen (1995)

Application area	Method	Decision context	Funding Agency	Citation
		development projects on a Finnish river	University of Technology	
	PROMETHEE	Prioritization of EIAs in Jordan	Staffordshire University, United Kingdom	Al–Rashdan et al. (1999)
Natural resource management	AHP	Natural park management	USDA Forest Services	Schmoldt et al. (1994); Peterson et al. (1994); Schmoldt & Peterson (2001b)
	AHP	Management of small forest in North Carolina, USA	USDA Forest Services	Rauscher et al. (2000)
	MAUT	Management of spruce budworm in Canadian forests	National Science and Engineering Research Council of Canada	Levy et al. (2000)
	AHP, MAUT, and outranking	Forestry planning in Finland	Finnish Academy of Sciences; Finnish Forest Research Institute	Kangas et al. (2001)
	MAUT	Improvement of habitat suitability measurements	Finnish Forest Research Institute	Store & Kangas (2001)
	AHP	Environmental vulnerability assessment	USEPA/USDOE	Tran et al. (2002)

Application area	Method	Decision context	Funding Agency	Citation
		for mid–Atlantic region		
	Weighting	Management of marine–protected areas in Tobago	U.K. Department of International Development	Brown et al. (2001)
	MAUT	Fisheries management: select among alternative commercial fishery opening days	Fisheries and Ocean, Canada	McDaniels (1995)
	AHP, MAUT, and outranking	Fisheries management		Mardle & Pascoe (1999)

Appendix B: Backgrounds of Multiple Criteria Decision

Making Approaches and the Earliest Applications

Methods	Studies
Analytic Hierarchy Process (AHP)	Saaty (1977, 1980, 1999)
Analytic Hierarchy Process (AHP)	Lootsman (1993); Hwang & Yoon, 1981
AHP was used to synthesize stakeholder preferences related to regional forest planning and to incorporate stakeholder preferences.	Ananda & Hearath (2008)
Presented an approach to select a suitable enterprise resource planning system for textile industry. Fuzzy AHP method was applied.	Cebeci (2009)
Application of AHP technique to more complicated cases was considered	Podvezko (2009)
Contracts ranking	Podvezko (2010)
Applied in business processes management	Stemberger et al. (2009)
An improved voting AHP data envelopment analysis methodology for supplier selection	Hadi–Vencheh & Nizai Motlagh (2011)
Presented new developments and maintenances of the existing infrastructures under limited government budget and time	Yan et al. (2011)
ELimination and Choice Expressing Reality (ELECTRE)	Benayoun et al. (1966)
ELimination and Choice Expressing Reality (ELECTRE)	Roy (1968, 1978, 1990, 1991, 1996)
ELimination and Choice Expressing Reality (ELECTRE)	Vallee & Zielniewicz (1994)

Methods	Studies
ELECTRE – Peculiarities of method applying	Thiel (2008)
ELECTRE – Selection problem	Ulubeyli & Kazaz (2009)
ELECTRE – Partner selection problem	Radziszewska–Zielian (2010)
ELECTRE – TRI method applied. Two authors introduced their own procedures that can be applied in the prenegotiation phase for eliciting negotiator's preference and building the offer scoring systems for parties.	Wachowiz (2010)
ELECTRE – Transport as an economic activity having complex interactions with the environment was investigated	Bojkovic et al. (2010)
PROMETHEE – Preference Ranking Organization Method for Enrichment Evaluation	Barns et al. (1984, 1986)
PROMETHEE – Preference Ranking Organization Method for Enrichment Evaluation	Barns & Mareeschall (1992)
PROMETHEE – Preference Ranking Organization Method for Enrichment Evaluation	Zahedi (1986)
Multi criteria analysis was used to evaluate the integrated performance of silvoarable agro forestry on hypothetical farms in 19 landscape test sites in Spain	Palma et al. (2007)
Revealed influence of the choice of preference functions and their parameters on the outcome of the evaluation	Podvezko & Podviezko (2010)
Porter's diamond model of competitive advantage was applied to establish evaluating criteria on urban competitiveness quality and a fuzzy set theory combining the PROMETHEE method was used to determine the priority projects.	Juan (2010)
Additive Ratio Assessment Method (ARAS)	Zavadskas & Turkis (2010)
ARAS – Integrated assessment of economic sectors	Balezentis & Balezentis (2011)

Methods	Studies
ARAS – Performance evaluation of project	Bakshi & Sarkar (2011)
Technique for Order of Preference by Similarity to Ideal Solution (TOPIS)	Hwang & Yoon (1981)
Technique for Order of Preference by Similarity to Ideal Solution (TOPIS)	Antucheviciene et al. (2010)
TOPIS – Selection of the most effective alternative in construction	Liaudanskiene et al. (2009)
TOPIS – Explored the multi–attribute decision–making problem based on the interval vague value	Liu (2009)
TOPIS – The problem of selecting the most effective road investment projects	Rudzianskaite–Kvaraciejiene et al. (2010)
TOPIS – The extended TOPIS method was proposed to solve multi–attribute group decision–making problems when the attribute values take the form of interval grey linguistic variables and attribute weight is unknown	Jin & Liu (2010)
TOPIS – A relative approach degree method of grey relation projection was presented to deal with multiple attribute–making in which the attributes' weight is unknown and attribute value is hybrid index.	Liu & Liu (2010)
TOPIS – Modified Fuzzy TOPIS was applied	Ham & Liu (2011)

Note. Adapted from "Multiple Criteria Decision Making (MCDM) Methods in Economics: An Overview," by Z. Turskis and E. K. Zavadskas, 2011, *Technological and Economic Development of Economy, 17*, p. 417.

Appendix C: Yin's Six Sources of Evidence

Source of Evidence	Strengths	Weaknesses
Documentation	• stable – repeated review • unobtrusive – exists prior to case study • exact – names, • broad coverage – extended time span	• retrievability – difficult • biased selectivity • reporting bias – reflects author bias • access – may be blocked
Archival Records	• same as above • precise and quantitative	• same as above • privacy might inhibit access
Interviews	• targeted – focuses on case study topic • insightful – provides perceived causal inferences	• bias due to poor questions • response bias • incomplete recollection • reflexivity – interviewee expresses what interviewer wants to hear
Direct Observation	• reality – covers events in real time • contextual – covers event context	• time–consuming • selectivity – might miss facts • reflexivity – observer's presence might cause change • cost – observers need time
Participant Observation	• same as above • insightful into interpersonal behavior	• same as above • bias due to investigator's actions
Physical Artifacts	• insightful into cultural features • insightful into technical operations	• selectivity • availability

Appendix D: Letter of Cooperation

XXXXXX

November 3, 2015
Millicent Davis
RE: Letter of Cooperation

Dear Millicent Davis,

> Based on our review of your research proposal, XXXXX gives permission for you to

conduct the study entitled Decision Making of Environmental Engineers on Project Selection within XXXXX. As part of this study, we authorize you to recruit participants from a list of potential participants from the Senior Engineer, contact the participants, and explain the purpose of the study and the potential social impact. We understand that you will send them via email or in person an employee participation consent form explaining their rights to participate in the study.

We will include in the list employees that represent the company's acquisition, quality, or project management teams, environmental engineers, and any other identified participants referred to you through using a snowball method that meet the case study criteria. We understand the criteria for this current study will include: (a) job assignment, (b) role within the organization, (c) knowledge of company operational methods, and (d) part of making decisions on environmental projects within the last five years. We understand the interviews will be audio recorded. A summary of the interview responses

will be provided to the participants in a transcript to review for accuracy. We also understand the findings of this study will be provided to participants and this firm. Finally, individuals' participation will be voluntary and at their own discretion.

We also understand that you are requesting internal documents that pertain to this study such as such as in–house information bulletins, environmental declarations, and annual reports for the current year., which the principal partners of this firm will provide for you. External sources such as press releases, web pages, trade registries, and such can be located on our website.

We understand that our organization's responsibilities include a secure environment for interviews, for which we are providing one of our conference rooms for interviews and a phone line to audio record interviews if requested. We reserve the right to withdraw from the study at any time if our circumstances change.

We confirm that we are authorized to approve research in this setting and that this plan complies with the organization's policies.

We understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the student's supervising faculty/staff without permission from XXXXX. UnlessXXXXX gives you permission to use its name in your study, then the study will not use XXXXX name or other identifying information in the study, and XXXXXX will be generically referred to as an environmental consulting engineering firm or be provided with a fictitious name.

Sincerely,

XXXXXXXXXX, Vice President

XXXXXXXX , Vice President

Appendix E Strider's Approval of Revised Interview Questions

LinkedIn

Dr. Sheila Hadley Strider
Relationship Manager/Human Resources Business Partner at ADP

Millicent

Please feel free to to use any part of my study that you feel would be useful in your study. Also, reach out to me if you need any assistance. I would be happy to help. I am so honored that you are choosing my material for your dissertation. Also, I am serving as dissertation chair in a DBA program and would be willing to help you if you could use my help.

On 04/08/15 11:53AM, Millicent Davis wrote:

Hello Dr. Strider my name is Millicent Davis and I am a doctoral student at Walden. My study is on project management. I would like to use your interview questions with a little revision to fit my study. Would u allow me to do that? I can send u the revised questions for your review but I will need to put your approval email or letter in the Appendix. I am about to go to URR and will need to have this solidified prior. Thank you in advance for your help.

Sincerely

Appendix F: Confidentiality Agreement for My Assistant with NVivo

CONFIDENTIALITY AGREEMENT

Name of Signer:

During the course of my activity in analyzing data for this research: Decision Making of Environmental Engineers on Project Selection, I will have access to information, which is confidential and should not be disclosed. I acknowledge that the information must remain confidential, and that improper disclosure of confidential information can be damaging to the participant.

By signing this Confidentiality Agreement I acknowledge and agree that:

1. I will not disclose or discuss any confidential information with others, including friends or family.
2. I will not in any way divulge, copy, release, sell, loan, alter or destroy any confidential information except as properly authorized.
3. I will not discuss confidential information where others can overhear the conversation. I understand that it is not acceptable to discuss confidential information even if the participant's name is not used.
4. I will not make any unauthorized transmissions, inquiries, modification, or purging of confidential information.
5. I agree that my obligations under this agreement will continue after termination of the job that I will perform.
6. I understand that violation of this agreement will have legal implications.

7. I will only access or use systems or devices I am officially authorized to access and I will not demonstrate the operation or function of systems or devices to unauthorized individuals.

Signing this document, I acknowledge that I have read the agreement and I agree to comply with all the terms and conditions stated above.

Signature: XXXXX Date: 9/18/15

Appendix G: Lincoln and Guba's Four Criteria for Trustworthiness

Quality Criterion	Possible Provision Made by Researcher
Credibility	Adoption of appropriate, well recognized research methods
	Development of early familiarity with culture of participating organizations
	Random sampling of individuals serving as informants
	Triangulation via use of different methods, different types of informants and different sites
	Tactics to help ensure honesty in informants
	Iterative questioning in data collection dialogues
	Negative case analysis
	Debriefing sessions between researcher and superiors
	Peer scrutiny of project
	Use of "reflective commentary"
	Description of background, qualifications, and experience of the researcher
	Member checks of data collected and interpretations/theories formed
	Thick description of phenomenon under scrutiny
	Examination of previous research to frame findings
Transferability	Provision of background data to establish context of study and detailed description of phenomenon in question to allow comparisons to be made
Dependability	Employment of "overlapping methods"
	In–depth methodological description to allow study to be repeated

Confirmability	Triangulation to reduce effect of investigator bias
	Admission of researcher's beliefs and assumptions
	Recognition of shortcomings in study's methods and their potential effects
	In–depth methodological description to allow integrity of research results to be scrutinized
	Use of diagrams to demonstrate "audit trail"

Note. Adapted from "Criteria For assessing the Trustworthiness of Naturalistic Inquiries," by E. Guba, 1981, *Educational Communication and Technology Journal, 29*, p.83, and from "Emerging Criteria for Quality in Qualitative and Interpretive Research," by Y. Lincoln, 1995, *Qualitative Inquiry, 1*, p.285.

Appendix H: Themes and Patterns

Coded Theme	# of participants who offered perception	% of participants who offered this perception
Theme 1: MCDM Assessment Process	4	100
Subtheme: Green Remediation	4	100
Theme 2: A Go/No–Go Assessment Process Selection	3	75
Theme 3: Education and Training	4	100
Subtheme: Mentoring	4	100
Theme 4: Ethics as Organizational Value	4	100
Theme 5: Good Project Management	4	100
Subtheme: Using Incentives for Employee Motivation	4	100

Appendix I: Participation Site's Go/No–Go Decision Matrix

	Proposal Factors	Decision Criteria						Estimated Rating		
		Negative		Neutral		Positive		Our Firm	Competitor A	Competitor B
		1	2	3	4	5	6			
1	Client Contact and Rapport	Known to client, but not well known		Known to client, but not well known		Well–developed relationship with client				
2	Marketing Intelligence	Did not expect RFP; project info limited to solicitation		Anticipated RFP, have collected adequate info		Distinct insights into client needs and expectations				
3	Competitive Advantage	Competitor is strongly favored		Open competition with no apparent favorite		Our firm in favored position for contract award				
4	Qualifications and Experience	Marginally qualified, limited or no relevant experience		Adequately qualified but no real edge over competitor		Technically superior to most competitors				
5	Project team availability	Needed team members are too busy or in distant offices		Needed team members have adequate availability		Very strong proposed team with good availability				

	Proposal Factors	Decision Criteria						Estimated Rating		
		Negative		Neutral		Positive		Our Firm	Competitor A	Competitor B
		1	2	3	4	5	6			
6	Profit Potential	Unlikely to make targeted profit on this project		Can meet profit goals if well managed		High likelihood to meet or exceed targeted profit				
7	Pricing Sensitivity	Selection primarily driven by price; commodity purchase		Client to balance price and qualifications in selection		Will select most qualified, then negotiate				
8	Cost to Respond	High proposal costs relative to odds of winning		Proposal costs appropriate relative to odds		Excellent ROI; cost very appropriate for the odds				
9	Consistency with Marketing Plan	Opportunity not consistent with stated marketing goals		Opportunity fits within our stated marketing goals		Opportunity can't be passed up relative to our goals				
10	Odds of Winning	0–30% chance of winning		30–60% chance of winning		60–90% chance of winning				
	Total Score (sum of 10 proposal factor ratings)									
	Overall Rating (total score divided by 10)									
	Comments:							Decision: □ Go □ No Go		

Appendix J: Summary of Theme 1

Interview Question	Conceptual Framework Components	Coded Themes	Lit Review Components	Participant Contribution
7: What instruction does the organization provide for MCDA assessment decision making? 10: How do you choose what method you will use for brownfield remediation projects? 12: Please explain how and why the method (does or does not) vary based on the type of brownfield remediation project? 13: Do you incorporate green remediation (GR) into your project selection? Why or why not and,	The MCDM theory applied to this study as MCDM includes goal–directed behavior in the presence of options and uncertainty (Durbach & Stewart, 2012). The MCDM theory can be used to explain relations between variables and offer descriptive information for environmental engineers to decide whether they can maximize profits and, at the same, time minimize toxic exposure (Bridges et al., 2005; Maxim, 2014).	Theme 1: MCDM Assessment Process Subtheme: Green Remediation	An understanding of multiple criteria decision making (MCDM) and multiple criteria decision (Charnes, Cooper, & Fergerson, 1955; Contini & Ziont, 1968; Kaklauskas, Trinkunas, & Zavadskas, 2007; Wallenius & Ziont, 1976). Brownfield redevelopment projects (Kim, Parker, Unger, & Yu ,2012) Brownfield remediation (Blackman, Lyon,	MCDM assessments can determine the best profitable scenario to use in a project (Vecchiato, 2012). Green remediation methods coincided with whatever the regulations require. (P1) noted that green remediation is sometimes client driven. (P2) discussed cost factors. (P3) offered more suggestions about what kind of remediation would come from the MCDM assessment

Interview Question	Conceptual Framework Components	Coded Themes	Lit Review Components	Participant Contribution
if you do, how do you do it? 14: How are business profit and or green initiatives applied to day–to–day business decision making?			Novak, & Wernstedt, 2013)	

Appendix K: Summary of Theme 2

	Conceptual Framework Components	Coded Themes	Lit Review Components	Participant Contribution
5: What personal attributes do environmental engineers in your organization exhibit that constitute profitable decision–making skills? 6: Who (what departments or level of employee) participates in the decision making? 7: What instruction does the organization provide for MCDA assessment decision making? 8: What does decision–making instruction consist of? 11: Does the method vary	Working in the environmental business brings much uncertainty and many options, which complicates having to decide how and whether to undertake projects (Bridges et al., 2005; Maxim, 2014).	Theme 2: A Go/No–Go Assessment Process Selection	Decision making in environmental undertakings is complicated, mainly because of the fundamental trade–offs between sociopolitical, environmental, ecological, and economic factors (Gomes & Partidario, 2013). The tradeoffs that project managers handle between agencies and organizations lead to many approaches to project selection (Eckerd & Heidelberg, 2015) The selection of suitable remedial approaches for contaminated sites, land use planning, and	All participants except one were involved in filling out the go/no–go matrix. (P4) stated no involvement in the go/no–go process In general, P1, P2, and P3 like using the go/no–go matrix as part of the process. (P1) stated that the go/no–go process captures the identifiers of a project that are necessary to determine whether the project should be taken on. (P3) stated that once the group makes the decision to move forward or not on a project, an

	Conceptual Framework Components	Coded Themes	Lit Review Components	Participant Contribution
with the type of project?			regulatory methods often involves multiple criteria such as financial difficulties, cost retrieval, liability matters, and maintaining a vision of redevelopment (Eckerd & Heidelberg, 2015).	officer gets involved.

Appendix L: Summary of Theme 3

Interview Question	Conceptual Framework Components	Coded Themes	Lit Review Components	Participant Contribution
1: What factors in your background influence the information of your business decision–making experiences? 2: What are examples of experiences that contributed to defining your decision–making standards? 3: What person(s) or event(s) in your background helped form your decision–making standards and how did the person(s) or event(s) help? 4: What characteristics of those events or experiences have you carried with you and how	Working in the environmental business brings much uncertainty and many options, which complicates having to decide how and if to undertake projects (Bridges et al., 2005; Maxim, 2014). For example, the MCDM theory can be used to explain relations between variables and offer descriptive information for environmental engineers to decide whether they can maximize profits and, at the same time, minimize toxic exposure (Bridges et al., 2005; Maxim, 2014)..	Theme 3: Education and Training Subtheme: Mentoring	Making important decisions in the absence of sufficient information and tools not only hinders one's performance and ability to maintain ethical and moral values, but also often hurts other stakeholders (Fast et al., 2012). While environmental decision–making strategies over the last several decades have evolved into complex, information–intensive, and multi–faceted approaches, frustration remains among all stakeholders. The reason for the	P1, P2, P3, and P4 noted that education, training, and mentoring give the participants a better insight into project management. (P1) stated that education and training empowers and prepares environmental engineers to deal with difficulty, uncertainty, diversity, and change. In general, P1, P2, P3, and P4 noted mentoring as a positive influence in their decision making. (P2) stated that mentor training has also led to an understanding of workplace

Interview Question	Conceptual Framework Components	Coded Themes	Lit Review Components	Participant Contribution
do the events or experiences that you have carried with you influence your decision making?			dissatisfaction is that combining multiple methodologies may result in the inability to track inconsistent stakeholder preference (Banaitienė et al., 2015).	values and behaviors. (P3) stated that mentoring has helped in knowing when to pursue or not pursue a project.”

Appendix M: Summary of Theme 4

Interview Question	Conceptual Framework Components	Coded Themes	Lit Review Components	Participant Contribution
4: What characteristics of those events or experiences have you carried with you and how do the events or experiences that you have carried with you influence your decision making? 5: What personal attributes do environmental engineers in your organization exhibit that constitute profitable decision–making skills? 8: What does decision–making instruction consist of?	N/A	Theme 4: Ethics as Organizational Value	Eckerd & Heidelberg (2015) identified many tools to choose from when doing remediation, and maintained that knowing the best tool or strategy is important because environmental issues often encompass ethical and moral values that are not associated with any economic use or value. Making important decisions in the absence of sufficient information and tools not only hinders one's performance and ability to maintain ethical and moral values,	Participants in this study noted that when responding to uncertainties and complexities in environmental projects, the direction must come from project managers and department heads. All participants talked about ethical decision making. (P2) described obligation to the organization to make a profit, obey the law, and to be ethical (P1) noted that management tries to pursue business that fits with the organization's goals,

Interview Question	Conceptual Framework Components	Coded Themes	Lit Review Components	Participant Contribution
			but also often hurts other stakeholders (Fast, et al., 2012). As a stakeholder in the management of the project, the environmental professional is involved with ethical decision–making and piloting the project toward the successful desired completion (Eckerd & Keeler, 2012).	objectives, and business plan. The company sets high ethical standards by pursuing opportunities that are good for the community. (P3) discussed problems with contaminated sites (P2) gave an example of bidding on a proposal and the factors that can come into play (P4) stated, "If it were a limited budget, within a competitive bid, with a simple project, with a defined scope, the organization would try to base the proposal on cost".

Appendix N: Summary of Theme 5

Interview Question	Conceptual Framework Components	Coded Themes	Lit Review Components	Participant Contribution
14: How are business profit and or green initiatives applied to day–to–day business decision making? 15. How does the organization define profitable decisions and how many, if any, profitable decisions have been made in the last five years? 16. How many non–profitable decisions have been made in the last five years? 17. How is profitable decision making rewarded in this organization	Environmental engineers have used MCDA methods in environmental management challenges, and because of these writings, many analyses, theories, and processes have been postulated (Charnes, Cooper, & Fergerson, 1955; Contini & Ziont, 1968; Kaklauskas, Trinkunas, & Zavadskas, 2007; Wallenius & Ziont, 1976). For example, the MCDM theory can be used to explain relations between variables and offer descriptive information for environmental engineers to decide whether they can maximize	Theme 5: Good Project Management Subtheme: Using Incentives for Employee Motivation	Decision making in environmental undertakings is complicated, mainly because of the fundamental trade–offs between sociopolitical, environmental, ecological, and economic factors (Gomes & Partidario, 2013). The tradeoffs that project managers handle between agencies and organizations lead to many approaches to project selection (Eckerd & Heidelberg, 2015). Managing a remediation project requires qualified professionals, such as	(P1) stated, Project managers have to deal with the uncertainness without hesitation or ambiguity. (P2) discussed the amount of project managers used on projects. (P4) stated, profitable decision making requires committed managers (P4) stated, it is important to offer incentives to motivate those that are included in the project to do their best. (P2) stated, rewards and incentives are thoughtful ways to

Interview Question	Conceptual Framework Components	Coded Themes	Lit Review Components	Participant Contribution
and what, if any, are the consequences of non–profitable decision making?	profits and, at the same time, minimize toxic exposure (Bridges et al., 2005; Maxim, 2014). Utilizing MCDM and MCDA can offer more effective decision–making tools for use in remediation projects(Bridges et al., 2005; Maxim, 2014) .		employees of an engineering firm (Eckerd & Keeler, 2012).	acknowledge that somebody has put in the effort to do their best. (P1) stated, the organization's business models is to, get the work, do the work, and get paid for the work.